

DOCUMENT RESUME

ED 078 662

EM 011 205

AUTHOR Caro, Paul W., Jr.
TITLE Equipment-Device Task Commonality Analysis and Transfer of Training. Technical Report 70-7.
INSTITUTION Human Resources Research Organization, Alexandria, Va.
SPONS AGENCY Office of the Chief of Research and Development (Army), Washington, D.C.
REPORT NO HumRRO-TR-70-7
PUB DATE Jun 70
NOTE 43p.

EDRS PRICE MF-\$0.65 HC-\$3.29
DESCRIPTORS Aircraft Pilots; *Comparative Analysis; Educational Programs; Equipment Evaluation; *Flight Training; Military Air Facilities; Military Training; *Simulators; *Task Analysis; Technical Reports; Trainers; Training; *Transfer of Training
IDENTIFIERS *Task Commonality Analysis; United States Army

ABSTRACT

Army researchers developed a system of procedures designed to enable training personnel to assess the utility of an existing flight training device for new training purposes. Such adaptations became a salient feature of military training due to the continuous modification of operational equipment. Using a candidate device for rotary wing training, they produced a system of procedures, called the Task Commonality Analysis (TCA), which allowed training personnel to: 1) identify task elements associated with criterion performance in the operational and training equipment; 2) compare the two sets of tasks; 3) estimate the extent to which task commonality is required for transferable training; and 4) specify the synthetic training program most likely to result in maximum positive transfer of training from device to operational equipment. Information derived from the TCA was used to predict transfer of training. Results indicated that the TCA provided an effective basis for assessing the potential value of a training device; they also showed the particular training device employed in this study to be of little use. (Author/PB)

ED 078662

Technical Report 70-7

AD _____

Equipment-Device
Task Commonality Analysis and
Transfer of Training

by

Paul W. Caro

HumRRO Division No. 6 (Aviation)

June 1970

Prepared for:

Office, Chief of
Research and Development
Department of the Army

Contract DAHC 19-70.C.0012

HumRRO

HUMAN RESOURCES RESEARCH ORGANIZATION

FILMED FROM BEST AVAILABLE COPY

This document has been
approved for public release
and sale; its distribution
is unlimited.

EW 011 205-



DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF RESEARCH AND DEVELOPMENT
WASHINGTON, D.C. 20310

6 June 1970

CRDBES

SUBJECT: Equipment-Device Task Commonality Analysis and Transfer of Training

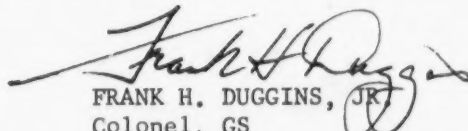
TO:

1. The research described in this report was designed to develop procedures that would enable training personnel to assess the utility of an existing device for new training purposes. The system of procedures, called Task Commonality Analysis (TCA), was developed in connection with the evaluation of a device for Army rotary wing instrument flight training. The procedures allow comparison of operational task stimulus and response elements with corresponding elements in synthetic training equipment. Application of Task Commonality Analysis to a candidate device is described.

2. It was concluded that the system for evaluating a training device by comparison of its task elements with those of operational equipment provides an objective basis for assessing the potential training value of a device. It was also concluded that relatively little task commonality exists between the specific device assessed in this research and the operational equipment.

3. This report should be of interest to those concerned with aviation training and to those involved in training program development in which there will be choices between the use of existing training devices and the development of new devices.

FOR THE CHIEF OF RESEARCH AND DEVELOPMENT:


FRANK H. DUGGINS, JR.
Colonel, GS
Chief, Behavioral Sciences
Division

ED 078662

Equipment-Device Task Commonality Analysis and Transfer of Training

by

Paul W. Caro

This document has been approved for public release
and sale; its distribution is unlimited.

June 1970

U. S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRO-
DUCED EXACTLY AS RECEIVED FROM
THE PERSON OR ORGANIZATION ORIG-
INATING IT. POINTS OF VIEW OR OPIN-
IONS STATED DO NOT NECESSARILY
REPRESENT OFFICIAL OFFICE OF EDU-
CATION POSITION OR POLICY.

Prepared for:
Office, Chief of Research and Development
Department of the Army
Contract DAHC 19-70-C-0012 (DA Proj 2Q062107A712)

HumRRO Division No. 6 (Aviation)
Fort Rucker, Alabama
HUMAN RESOURCES RESEARCH ORGANIZATION

Technical Report 70-7
Work Unit ECHO IV

The Human Resources Research Organization (HumRRO) is a nonprofit corporation established in 1969 to conduct research in the field of training and education. It is a continuation of The George Washington University Human Resources Research Office. HumRRO's general purpose is to improve human performance, particularly in organizational settings, through behavioral and social science research, development, and consultation. HumRRO's mission in work performed under contract with the Department of the Army is to conduct research in the fields of training, motivation, and leadership.

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

Published

June 1970

by

HUMAN RESOURCES RESEARCH ORGANIZATION

300 North Washington Street

Alexandria, Virginia 22314

Distributed under the authority of the
Chief of Research and Development
Department of the Army
Washington, D.C. 20310

FOREWORD

The overall objectives of Work Unit ECHO are to survey and evaluate current synthetic flight training in Army aviation; to determine experimentally the value of selected flight training devices; and to establish guidance for the development and effective utilization of flight training devices in present and future aviation training curricula. Activities directed toward these objectives were begun by the Human Resources Research Organization in FY 1964 at Fort Rucker, Alabama.

In Sub-Unit ECHO I, a survey of synthetic flight training equipment and practices was conducted at the U.S. Army Aviation School and at aviation field units within the continental United States. In ECHO II, the training value of a device embodying the captive helicopter concept was evaluated. In ECHO III, an evaluation was conducted of training devices, designed originally for fixed wing training, used in a rotary wing instrument training program. Costs associated with both flight and synthetic flight training in that program also were studied. The ECHO III research has been reported in Isley, Robert N., Caro, Paul W., Jr., and Jolley, Oran B., *Evaluation of Synthetic Instrument Flight Training in the Officer/Warrant Officer Rotary Wing Aviator Course*, HumRRO Technical Report 68-14, November 1968; and Jolley, Oran B., and Caro, Paul W., Jr., *A Determination of Selected Costs of Flight and Synthetic Flight Training*, HumRRO Technical Report 70-6, April 1970. The present Technical Report describes research conducted under ECHO IV. The ECHO III and ECHO IV research dealt with the same training program and equipment. The research was performed and most of the report preparation completed while HumRRO was part of The George Washington University.

The ECHO research was performed by HumRRO Division No. 6 (Aviation) at Fort Rucker. The Director is Dr. Wallace W. Prophet; Dr. Paul W. Caro is the Work Unit Leader. Military support for the study was provided by the U.S. Army Aviation Human Research Unit, Fort Rucker. LTC Edward B. Covington, III, was the Unit Chief at the time the research was conducted. LTC Ralph V. Gonzales was the Unit Chief during preparation of the draft report. LTC Dunell V. Schull is the present Unit Chief.

HumRRO research for the Department of the Army is conducted under Army Contract DAHC 19-70-C-0012. Training, Motivation, and Leadership research is conducted under Army Project 2Q062107A712.

Meredith P. Crawford
President
Human Resources Research Organization

SUMMARY AND CONCLUSIONS

MILITARY PROBLEM

A frequently occurring problem in Army Training is the adaptation of training equipment from one training requirement to another. Each time operational equipment undergoes modification or a model change, the suitability of available training devices comes into question. Frequently, when new equipment is procured, funds are not available for development of appropriate training devices to go with it, and improvisations are adopted.

When the Army undertook instrument flight missions in rotary wing aircraft, no training devices were available to support the necessary instrument training programs. Devices that were being used for fixed wing instrument training were modified to a quasi-rotary wing configuration and were used in rotary wing instrument training programs. The effectiveness of the training given in these modified devices was subjected to experimental investigation, and they were found to be of no demonstrable value in meeting rotary wing instrument training objectives.

ECHO IV, a follow-up study, was undertaken to provide guidance as to means for more effective utilization of the modified devices in meeting the Army's requirements for rotary wing instrument training. Because of the general nature of the problem of effective use of available training devices, however, the follow-up study was oriented toward the broader objective of developing generalizable, systematic, analytic procedures that would enable training personnel to assess the utility of a variety of existing devices for new training purposes.

RESEARCH PROBLEM

The use of existing devices for purposes for which they were not designed requires analyzing both an operational man-machine system and training devices designed for a different system in order to ascertain where common task elements lie. Using the information thus developed, principles of transfer of training may be applied to design a training program to maximize positive transfer of training and minimize negative. The development of procedures to accomplish such analyses was the research problem of the present study.

APPROACH

The approach taken in this study was to devise systematic procedures to:

- (1) Identify task elements associated with criterion performance in the operational equipment.
- (2) Identify task elements associated with performance in the training device.
- (3) Systematically and objectively compare task elements associated with performance in the equipment and in the device.
- (4) Estimate the extent to which task commonality is required for transferable training to be feasible.
- (5) Specify the nature of the synthetic training program most likely to result in maximum positive and minimum negative transfer of training from device to operational equipment.

RESULTS

Using the modified device employed in Army rotary wing instrument training as a vehicle for the research, procedures were developed for an equipment-device Task Commonality Analysis (TCA). Information derived through the TCA then was used to predict the occurrence of both positive and negative transfer of training from the device to the operational equipment. On the basis of these predictions, characteristics of training programs for use with the device in rotary wing instrument training were stated.

CONCLUSION

It was concluded that the systematic comparison of task elements involved in performance in training devices and operational equipment could provide an objective basis for development of effective training programs. The TCA procedures developed in this study can be used wherever training programs are developed which include training devices not optimized for use in the programs. Such situations occur wherever existing devices are modified to meet new training requirements or when "off-the-shelf" devices are procured for use in specialized training programs.

In the case of the device employed as a vehicle for the research described in this report, it was concluded that relatively little task commonality exists between it and the operational equipment. Predominantly negative transfer of training was predicted from its use, a prediction that tended to be supported by the earlier transfer of training study.

CONTENTS

	Page
Background of the Research	3
Introduction	3
The ECHO III Study	3
Problem and Approach	4
Military Problem	4
Research Problem	4
Research Approach	5
Development of Task Commonality Analysis Procedures	5
Analysis of Stimuli in the Operational Equipment	5
Analysis of Stimuli in the Training Device	6
Equipment-Device Task Element Comparison	7
Analysis of Criterion Performance	10
Determination of Training Program Characteristics	11
Transfer of Training Considerations	11
Response Commonality and Prediction of Transfer of Training	11
Aircraft Control	11
Communication	13
Additional Training Program Considerations	13
Environmental Simulation	13
Aircraft Malfunction	14
Development of a Training Program	15
Conclusion	15
Appendix	
A Displays and Controls Found in the TH-13T Aircraft	19
B Displays and Controls Found in 1-CA-1 Device Modified at USAAVNS to a Rotary Wing Configuration	23
C Modified 1-CA-1 Displays and Controls Which Are Operational in a Majority of the Available Devices	25
D Analysis of a Representative Flight Maneuver Performed During a Tactical Instrument Mission in the TH-13T Aircraft	27
Table	
1 TH-13T Displays and Controls and Their Counterparts in the Rotary Wing Modified 1-CA-1	8
2 Ratings of Realism of Displays Important in Aircraft Control Common to Both the TH-13T and the 1-CA-1	9
3 Ratings of Realism of Controls Important in Aircraft Control Common to Both the TH-13T and the 1-CA-1	9

**Equipment-Device
Task Commonality Analysis and
Transfer of Training**

BACKGROUND OF THE RESEARCH

INTRODUCTION

Recent expansion of Army aviation and the emphasis on helicopter operations have put a heavier burden upon the Army's capability for training rotary wing aviators. To meet these increased aviator training requirements, training concepts and techniques have been adopted which reasonably can be expected to increase the efficiency of rotary wing training. The use of synthetic flight training devices, for example, has become widely accepted in Army aviator training programs. Their use is based on the assumption that training in the device (a) will transfer to the aircraft, and (b) is more efficient and/or less expensive than equivalent training given in the aircraft.

The Army is currently developing a system of rotary wing trainers designed specifically to meet its requirements for rotary wing synthetic training devices.¹ Pending development of this Synthetic Flight Training System, however, the U.S. Army Aviation School is relying on available devices in its rotary wing program. One such device is a fixed wing instrument trainer, Device 1-CA-1, which has been modified to a quasi-rotary wing configuration. The modified 1-CA-1 is used to provide training in the skills required for instrument flight to officer-students and warrant officer candidate-students enrolled in the Tactical Instrument Phase of the Officer/Warrant Officer Rotary Wing Aviator Course (O/WORWAC).²

The 1-CA-1 was originally designed and manufactured in the late 1940s, and a number of studies have indicated that training in the device can lead to reductions in the amount of flight time required to complete training programs for fixed wing aviators, or to improved aviator proficiency, or to both.³ Until recently, however, no studies were reported of the effectiveness of this device when modified for use as a synthetic trainer in rotary wing instrument programs.

THE ECHO III STUDY

During FY 1967, an experimental evaluation was conducted as part of HumRRO Work Sub-Unit ECHO III, to determine the contribution to inflight performance of rotary wing synthetic training being given in modified 1-CA-1 devices at the U.S. Army Aviation School.⁴ Students who received instruction according to the prescribed syllabus in these devices (in addition to a prescribed program of inflight training) were compared with students who received only half as much device instruction and to students who received no device training at all. It was reasoned that differences in flight performance

¹Paul W. Caro, Jr. "Adaptive Training—An Application to Flight Simulation," *Human Factors*, vol. 11, no. 6, 1969, pp. 569-576; also issued as HumRRO Professional Paper 5-70, March 1970.

²For a brief description of O/WORWAC, see: Robert N. Isley, Paul W. Caro, Jr., and Oran B. Jolley. *Evaluation of Synthetic Instrument Flight Training in the Officer/Warrant Officer Rotary Wing Aviator Course*, HumRRO Technical Report 68-14, November 1968, pp. 5-6.

³Smode, A.F., Hall, E.R., and Meyer, D.E. *An Assessment of Research Relevant to Pilot Training*, AMRL-TR-66-196, Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio, November 1966.

⁴HumRRO Technical Report 68-14, *op. cit.*

among groups, if any, would indicate the training contribution of the device and its associated programs of instruction to trainee flight performance.

The results of the ECHO III study showed that, overall, there were no consistent indications that the device-trained groups differed from the groups without such training. The few significant differences among groups were irregular in direction and so few as to suggest that they were chance findings. It was concluded that the synthetic instruction given in the modified devices in the O/WORWAC at the time of the study did not contribute significantly to trainee flight performance.

The ECHO III research involved an evaluation of the modified 1-CA-1 device combined with the program of instruction then in use at the Aviation School. The study indicated only that the combination of the device and its associated training program contributed nothing of significance to the development of trained pilots. It did not indicate whether the primary deficiency lay with the device itself or with the associated synthetic training program, that is, whether the device was inherently unsuitable for the intended application or whether it merely was being used in an ineffective manner. Therefore, a follow-up study was undertaken to develop a program of synthetic flight instruction for use with the rotary wing modified 1-CA-1. The intent of ECHO IV, the follow-up study, was to develop a program which would exploit the training capabilities of the device and, at the same time, avoid attempting to use it to teach flight skills for which it might be inappropriate.

PROBLEM AND APPROACH

MILITARY PROBLEM

The problem of making appropriate use of training devices is not restricted to rotary wing training or even to flight training generally. In a larger context, the Army and other organizations often face the problem of adapting training equipment from one task to another. Each time operational equipment undergoes modification or a model change, the suitability of available training devices comes into question. Frequently, when new equipment is procured, funds are not available for appropriate training devices to go with it, and improvisations are adopted. The improvisation—as with the 1-CA-1 trainer—is almost certain to be less than optimally suited for the instructional requirement, since it is not specifically modeled on the operational tasks and equipment. It is consequently difficult for a training officer to know how to use the device, or indeed, whether it is efficient to use it at all.

ECHO IV, therefore, in addition to investigating the possible usefulness of the 1-CA-1s with a revised training program, was oriented toward a broader objective: to develop systematic, analytic procedures that would enable training personnel to assess the utility of an existing device for a new training purpose (or to evaluate an “off-the-shelf” device for use in fulfilling a specific training requirement). This orientation relegated the development of a training program which could make effective use of the Army's rotary wing modified 1-CA-1 to being an objective of secondary importance. Nevertheless, interest in improved use of the modified 1-CA-1 made that device a desirable vehicle for the development of the broader procedures.

RESEARCH PROBLEM

Ideally, equipment, job, required personnel characteristics, training devices, and programs of instruction should be designed in concert with one another—the systems approach taken in modern man-machine developments. Basic to developing the human factors and training aspects of a man-machine system is a careful and thorough identification, through analysis of operational requirements, of the tasks human beings will perform in that system. Training programs and training devices with associated programs of instruction can then be developed from task analytic data, employing the psychological principles of transfer of training. That is, programs of training to be conducted using synthetic devices can be devised to assure that knowledges and skills are acquired that are directly usable in operational equipment (i.e., assure positive transfer), and also to assure minimum acquisition of

skills and knowledges that would interfere with performance using operational equipment (i.e., minimize negative transfer).

Applying the techniques of task analysis and the principles of transfer of training to the development of training programs for existing devices is, essentially, a retrofit process. The use of existing devices for purposes for which they were not designed requires analyzing both an *operational* man-machine system and *existing* training devices designed for a different system, in order to ascertain which task elements are common, and then applying principles of transfer of training, on a post hoc basis, to develop a program to maximize positive transfer and minimize negative.

From the research perspective, it is necessary to develop a systematic procedure to accomplish this. Such a procedure might be called an *equipment-device Task Commonality Analysis (TCA)*. Task elements found to be common to the operational equipment and the device can then be used as the raw material for study. At one extreme, the TCA might indicate there is essentially no potential for positive transfer of training, either because common elements are lacking, or because interference elements cannot be avoided. At the other extreme, the TCA might identify sufficient commonality to assure probable substantial positive transfer of training with few, if any, interfering elements being present.

RESEARCH APPROACH

The approach in this study, therefore, consisted of devising systematic procedures to:

- (1) Identify task elements associated with criterion performance in the operational equipment.
- (2) Identify task elements associated with performance in the training device.
- (3) Systematically and objectively compare task elements associated with performance in the equipment and the device.
- (4) Estimate the extent to which task commonality is required for transferable training to be probable.

Once procedures for an equipment-device TCA have been devised, it then becomes possible to determine the characteristics of a training program for use with the device that would be consistent with the psychological principles of transfer of training.

DEVELOPMENT OF TASK COMMONALITY ANALYSIS PROCEDURES

ANALYSIS OF STIMULI IN THE OPERATIONAL EQUIPMENT

Criterion performance in the Tactical Instrument Phase of the O/WORWAC,⁵ the course which served as a vehicle for the present research, consists of accomplishing, during a simulated tactical instrument flight, certain aircraft and navigation tasks. These tasks involve making specific responses to stimuli present during the flight. The first part of the problem found in the present study was that of specifying the stimuli present in the criterion situation and the responses elicited by them.

⁵The Tactical Instrument Phase of the O/WORWAC, introduced in late 1965, was designed to prepare rotary wing aviators to operate under instrument flight conditions in a tactical situation. Graduates were qualified for a Tactical Instrument Rating. The Standard Instrument Rating, which allows graduates to operate under FAA Instrument Flight Rules, at the time of the research was awarded following completion of another training course, the Helicopter Instrument Flight Course. Many flight skills were common to these two courses. Since this research was conducted, the Tactical Instrument Phase of the O/WORWAC has been replaced by a phase leading to the award of a Standard Instrument Rating. Further information about the training relevant to the present study may be found in HumRRO Technical Report 68-14, *op. cit.*

These inflight stimuli are of two types: (a) hardware, that is, the displays and controls found inside⁶ the cockpit of the aircraft; and (b) non-hardware, that is, the factors which relate to the mission being flown. Examples of non-hardware stimuli include environmental influences, such as winds, and verbal instruction received via radio, such as flight clearances.

Appendix A contains a list of all displays and controls found in the TH-13T aircraft, and was compiled by examining the aircraft itself and its Operator's Manual.⁷ Since the purpose of the list was to enable the researchers to identify all the hardware stimuli to which an aviator might be responding during criterion performance, the list is exhaustive. For example, in identifying the displays and controls, no assumptions were made concerning whether any item had significance for training. The complete listing of these hardware stimuli is given in Appendix A.

The question of whether a particular stimulus in the criterion equipment has relevance for training must be resolved if a determination is to be made concerning the adequacy of a synthetic training device. To resolve the question with respect to the TH-13T hardware stimuli, the list was given to six instructor pilots whose primary duty at the time was to conduct Tactical Instrument Training in the O/WORWAC. The instructors were told to, "Delete from this list all those displays and controls which are not employed in the conduct of O/WORWAC Tactical Instrument Training in the TH-13T."

It was the consensus of the instructors queried that trainees in the course under study were required to respond to all displays and controls in the TH-13T cockpit except those associated with the VOR and ILS instrument navigation equipment. These items are so indicated in Appendix A.

With respect to non-hardware stimuli, interviews of these same instructor pilots verified that, during criterion performance, aviators are required to respond to all radio and interphone communications directed to them or their aircraft, electromagnetic signals received from ground-based radio navigation facilities, and factors associated with the weather through which the aircraft is flying.

ANALYSIS OF STIMULI IN THE TRAINING DEVICE

Paralleling the determination of the stimuli to which an aviator responds in the operational equipment, was the determination of the stimuli to which he must respond in the training device. These stimuli also are of two types—hardware and non-hardware.

Appendix B contains a list of all the displays and controls found in those 1-CA-1 devices at the U.S. Army Aviation School which have been modified to a quasi-rotary wing configuration. As is the case for the TH-13T, the list of modified 1-CA-1 displays and controls is exhaustive. The modifications were made locally by personnel assigned to the Aviation School, and there is some variation from device to device. Therefore, in compiling the list, each⁸ device was examined, and the items contained in Appendix B are not all found in any one device.

In addition to a lack of standardization among these devices with respect to the presence of specific displays and controls, a number of the items, generally present in the

⁶For the purposes of the present study, only stimuli present within the cockpit during flight were considered. Since the 1-CA-1 devices were designed to simulate flight under instrument flight conditions, i.e., weather, and since no out-of-the-cockpit visual displays are incorporated in it, no consideration was given to stimuli unique to flight under visual flight conditions.

⁷TM 55-1520-226-10, October 1969.

⁸There were 51 such devices at the time of the research reported here.

devices, do not function or function in such manner that they are not considered usable by the device instructors. For example, most of the engine-instrument displays that are present do not function at all; the standby compasses incorporate errors as high as 60°; the engine tachometer registers zero RPM when the master switch is off and a fixed operational value when the master switch is on. Further, some of the displays and controls in the device have no counterpart in the TH-13T, such as the pitot heater switch and the trainer lock-release lever.

Accordingly, a revised list of displays and controls was prepared and is presented in Appendix C. It contains all of the hardware stimuli that were considered appropriate for consideration in this study, that is, all those displays and controls which (a) are operable, and (b) are found in a majority of the rotary wing modified 1-CA-1 devices. It is the list in Appendix C which was used for further study.

With respect to non-hardware stimuli, it was determined that verbal instructions, simulating radio and interphone communications, can be given to trainees in the device through a headset—the simulation originating from the instructor of the device's instructor station. In addition, electromagnetic signals from a single—but programmable—ground radio navigation station, wind velocity and direction, and turbulence levels may be simulated.

EQUIPMENT-DEVICE TASK ELEMENT COMPARISON

The lists of controls and displays (hardware stimuli) found in the operational environment and in the training device were compared. For each stimulus in the TH-13T, a comparable stimulus was sought in the device. In some cases, almost identical counterparts were found—for example, both contain an Airspeed Indicator and a Cyclic Control. In other cases, some variation occurred between the aircraft and the trainer, but a common function could be identified; for example, the Microphone Switch in the device is comparable in function to both the Radio Microphone Switch and the ICS Microphone Switch in the TH-13T, and the aircraft's Elapsed Time Clock performs (but is not limited to) the function of the trainer's Eight-Day Clock. Table 1 contains a list of all of the TH-13T displays and controls for which counterpart items could be identified in the modified 1-CA-1.

In order to evaluate the degree of similarity between the two sets of stimuli, 11 TH-13T instructor pilots from the Tactical Instrument Phase of the O/WORWAC were asked, while "flying" typical modified 1-CA-1s, to evaluate each of the device's 10 displays that are identified in Table 1. The instructors indicated independently their opinions as to whether the (a) appearance, and (b) function of each of the displays were realistic or unrealistic in comparison with the corresponding instrument in typical Army helicopters.⁹ In Table 2 the instructor evaluations—or "realism ratings"—are summarized as percentages rated "realistic"¹⁰ for each of the displays. The instructors reported that, without exception, the evaluated displays were realistic in both appearance and function. Thus, it was concluded that stimulus commonality does exist between these displays in the trainer and in the operational equipment.¹¹

⁹The comparisons were made between the 1-CA-1 and a hypothetical "typical Army helicopter" rather than the TH-13T specifically. The reason for this comparison was the assumption that training useful for typical helicopters probably would be useful in the TH-13T. The TH-13T of course, is a typical Army helicopter in many respects, although it is not employed tactically.

¹⁰The "realism ratings" were two-point scales, so far as individual raters were concerned: realistic or unrealistic. The purpose of a two-point scale was to increase the probable reliability of each rating.

¹¹It should be noted that the comparisons made by these instructors were made under dynamic conditions appropriate to the task under study, i.e., while the devices were being "flown." It was presumed that the realism judgments were made in relation to corresponding displays in a typical Army helicopter under dynamic, i.e., flight, conditions.

Table 1

**TH-13T DISPLAYS AND CONTROLS AND THEIR COUNTERPARTS IN
THE ROTARY WING MODIFIED 1-CA-1^a**

Rotary Wing Modified 1-CA-1 Device	TH-13T Aircraft
Displays	
Airspeed Indicator	Airspeed Indicator
Attitude Indicator	Attitude Indicator
Altimeter	Altimeter
Turn and Slip Indicator	Turn and Slip Indicator
Radio Magnetic Indicator Heading Card	Bearing Heading Indicator (BHI) Heading Card
Vertical Velocity Indicator	Vertical Velocity Indicator
Manifold Pressure Gage	Manifold Pressure Gage
Radio Magnetic Indicator ADF Pointer	Bearing Heading Indicator ADF Pointer
8-Day Clock	Elapsed Time Clock
Radio Call Label	Radio Call Placard
Controls	
Cyclic	Cyclic
Pedals	Tail Rotor Control Pedals
Collective	Collective
Attitude Indicator Pitch Adjustment Control	Attitude Indicator Pitch Adjustment Control
Altimeter Setting Control	Altimeter Setting Control
Ignition Switch	Ignition Switch
Master Off-On Switch	Battery On-Off Switch
Volume Control	Signal Distribution Volume Control
Microphone Button	Radio and ICS Microphone Switches
8-Day Clock Set and Control Knob	Elapsed Time Clock Set and Control Knob
Instrument Lights Off-On Switch	Instrument Light Circuit Breaker
Cockpit Lights Rheostat	Cockpit Lights Rheostat

^aOnly displays and controls that are used in tactical instrument training are included.

The commonality of the controls identified in Table 1 was determined in a similar manner. The same 11 TH-13T instructor pilots, while seated in typically modified 1-CA-1s, were asked to provide realism ratings of the 1-CA-1 controls along five dimensions: (a) appearance, (b) location, (c) direction(s) of movement, (d) control feel, that is, amount of pressure required to activate the control and the tactual feedback to the pilot, and (e) the effect of control activation upon the appropriate displays. The realism ratings for the 12 controls involved are indicated in Table 3. With respect to the dimensions evaluated, it can be seen that the Cyclic, Pedals, Collective, Master Off-On Switch, and Instrument Lights Off-On Switch tended to be rated as unrealistic in comparison to corresponding controls in typical Army helicopters, while the other seven controls tended to be rated as realistic.¹²

The realism of non-hardware stimuli associated with the device was judged by the research staff after consultation with TH-13T instructor pilots. It was decided that

¹²The previous note concerning the dynamic conditions under which the ratings of display realism were made, applies to the rating of controls as well.

Table 2

**RATINGS OF REALISM OF DISPLAYS
IMPORTANT IN AIRCRAFT CONTROL
COMMON TO THE TH-13T AND THE 1-CA-1^a**

Display	Percent Realistic	
	Appearance	Function
Airspeed Indicator	91	73
Attitude Indicator	73	91
Altimeter	91	91
Turn and Slip Indicator	73	91
Radio Magnetic Indicator		
Heading Card	100	100
Vertical Velocity Indicator	73	91
Manifold Pressure Gage	64	73
Radio Magnetic Indicator		
ADF Pointer	100	100
8-Day Clock	100	82
Radio Call Label	80	100

^aThe data indicate the percentage of the 11 responding TH-13T pilots who rated each instrument realistic or unrealistic in terms of its appearance and function.

Table 3

**RATINGS OF REALISM OF CONTROLS IMPORTANT IN AIRCRAFT CONTROL
COMMON TO BOTH THE TH-13T AND THE 1-CA-1^a**

Controls	Appearance	Location	Direction(s) of Movement	Control Forces	Effect Upon Displays
Cyclic	36	9	9	64	78
Pedals	45	55	9	45	55
Collective Pitch	27	9	100	36	27
Attitude Indicator Horizontal Adjustment Control	73	82	91	71	90
Altimeter Adjustment Control	100	100	100	100	100
Ignition Switch	80	55	80	86	70
Master Off-On Switch	27	9	56	57	25
Volume Control	64	55	80	70	67
Microphone Button	73	78	100	86	100
8-Day Clock Set and Control Knob	91	55	100	100	100
Instrument Lights Off-On Switch	0	9	40	50	44
Cockpit Lights Rheostat	55	45	100	100	91

^aThe data indicate the percentage of 11 responding TH-13T instructor pilots who rated each control realistic or unrealistic in terms of the appearance, location, etc.

simulated radio and interphone communication were essentially identical in content and of generally superior quality to such communication in the TH-13T during an operational mission. Electromagnetic signals from simulated ground stations affect navigation instrument displays in the trainer in a manner essentially identical to the manner in which corresponding displays are affected in the aircraft. Aural identifiers associated with ground radio navigation facilities, however, are not present in the trainer.

The influences of winds upon the aircraft are represented realistically in the device, since both wind direction and velocity are simulated. Turbulence may be simulated, but the levels involved are not as great as are sometimes experienced in the aircraft. Effects of other weather factors, such as rain and ice, cannot be simulated in the device, but magnetic variation may be simulated realistically.

ANALYSIS OF CRITERION PERFORMANCE

The portion of the TCA described above suggests some limits that might be placed upon the use of a training device in a specific training situation, but the extent to which commonality is *required* for training to take place also must receive attention. Subjectively, it might be suspected, for example, that a low realism rating for the device's Instrument Lights Off-On Switch might not be a severe limitation to use of the device for instrument training. It might even be suspected that effective training could be provided in the device with no such control present at all. The question which arises, then, is: What stimuli are required in order to use a device for training oriented toward a specific operational requirement? In other words, what are the stimulus components of criterion performance?

In order to answer this question, an analysis was made of representative flight maneuvers¹³ involved in criterion performance. Again using the O/WORWAC as the vehicle for the research, these maneuvers consisted of a TH-13T instrument take-off and climb to altitude; an ADF orientation, tracking, approach and missed approach; holding over a beacon; and an autorotation. In addition, accelerations, decelerations, turns, and recovery from unusual attitudes were included in the analysis. Performance of these maneuvers under limited visibility conditions constitutes most of the Army's tactical instrument mission. Consequently, the aircraft displays and controls involved in them are those which are the most significant from the standpoint of the training course under study.

The analysis of the instrument take-off and climb is included in this report as Appendix D in order to illustrate the level of detail involved in these analyses. It will be noted that emphasis is placed upon identification of the stimuli and responses involved in the execution of the maneuvers analyzed. Thus, the analysis identified the TH-13T displays and controls which are required to be employed in the accomplishment of criterion performance. In addition, it identified the responses a pilot makes to these stimuli while accomplishing criterion performance. Non-hardware stimuli were not addressed directly in these analyses; however, their effects constitute secondary tasks which must be performed by the trainee, such as responding to instruction received via radio and overcoming the effects of environmental factors while controlling the aircraft.

The task analysis indicated that, during the maneuvers analyzed, each of the TH-13T displays identified in Table 1 provided necessary stimuli to the pilot except the Radio

¹³ An analysis of all aspects of the tactical instrument mission of Army aviation, as performed in the TH-13T aircraft, was beyond the capability of the research staff with the resources available. While such an analysis would be desirable for purposes of developing an optimum, mission-oriented instrument training program for the Army aviator, the analysis of representative portions of the operational mission was judged adequate to provide data for the present research.

Call Placard. The analysis assumes that the information contained on the Placard is known to the pilot, and he therefore does not need to refer to it during the maneuvers analyzed.

The analysis also indicated a display required to perform these maneuvers in the aircraft which is not contained in Table 1, the Engine and Rotor Tachometer.

The analysis also indicated that each of the TH-13T controls listed in Table 1, except the Attitude Indicator Pitch Adjustment Control, the Ignition Switch, the Battery On-Off Switch, the Instrument Light Circuit Breaker, and the Cockpit Lights Rheostat, were necessary to performance of the maneuvers analyzed. The analysis assumed, however, that the Attitude Indicator Pitch Adjustment Control has been set properly; otherwise performance of these maneuvers would be unduly difficult. The analysis also indicates an important omission from Table 1, the Throttle Control, about which more will be noted later.

DETERMINATION OF TRAINING PROGRAM CHARACTERISTICS

TRANSFER OF TRAINING CONSIDERATIONS

The purpose of developing the analytic procedures described above was to make it possible to predict transfer of training accomplished in the device to the operational equipment. Principles of transfer of training, therefore, must enter into consideration. The principles which may be used as guidelines for forecasting improved criterion performance as a result of device training may be summarized as follows:

- (1) Positive transfer will occur when both stimuli and responses are similar in the training situation (e.g., the 1-CA-1) and the criterion situation (e.g., tactical instrument flight in the TH-13T).
- (2) Negative transfer will occur when the stimuli are similar in the training and the criterion situations, but the responses to the similar stimuli are different.

The intent of device training is, of course, to maximize those situations where positive transfer may be predicted and to avoid completely, if possible, those situations in which negative transfer may be predicted.

RESPONSE COMMONALITY AND PREDICTION OF TRANSFER OF TRAINING

The TCA described above identified the stimuli and responses involved in criterion performance and the extent to which those stimuli are common to both the operational equipment and the training device. The next consideration to be addressed is response commonality, that is, the extent to which responses made in the criterion environment may be made in the training device. With information concerning both stimulus and response commonality in hand, prediction of positive or negative transfer of training will be possible.

Aircraft Control

The more obvious responses under consideration are those related to aircraft control, and they were identified in the analyses described above of criterion performance. Aircraft control may be defined as the actions of the pilot as he closes the loop between displayed information and control inputs in order to maintain a steady state condition or to proceed from one steady state condition to another. Thus, in controlling the aircraft

(or simulated aircraft), the pilot responds through the aircraft controls to information (stimuli) he receives. Where relatively inexperienced instrument students are concerned, this information comes principally from instruments on the panel and feedback from the controls themselves. Proprioceptive and auditory cues associated with aircraft motion and sound have relatively little effect upon transfer of training during early stages of training.¹⁴

The displays used in aircraft control that are common to both the TH-13T and the modified 1-CA-1 (see Table 1) are (a) the Airspeed Indicator, (b) the Attitude Indicator, (c) the Altimeter, (d) the Turn and Slip Indicator, (e) the Bearing Heading Indicator (BHI) Heading Card, (f) the Vertical Velocity Indicator, and (g) the Manifold Pressure Gage. Except for the Manifold Pressure Gage, which is the primary indicator of the amount of power applied by the pilot, these instruments are useful for those aspects of aircraft control that do not involve aircraft subsystem control (e.g., engine and fuel subsystem control).

Reference to Table 2 indicates that these seven instrument displays were generally judged to be realistic in both appearance and function. Thus, it was concluded that similarity exists between these seven stimuli in the training device and in the criterion environment.

The analysis of maneuvers performed in the TH-13T indicated a display important to aircraft control which is not present in the 1-CA-1. It is the Engine and Rotor Tachometer.¹⁵ The absence of this important display constitutes a significant dissimilarity of stimuli between the training and the criterion situation.

The responses important to aircraft control require the appropriate manipulation by the pilot of certain levers, pedals, switches, knobs, and so forth, in the aircraft or simulated aircraft. The controls identified in the criterion performance analysis as being important to aircraft control that are common to both the TH-13T and the 1-CA-1 were determined to be (a) the Cyclic, (b) the Pedals, (c) the Collective, (d) the Altimeter Setting Control, (e) the Signal Distribution Volume Control, (f) the Radio Microphone Switch, and (g) the Elapsed Time Clock Set and Control Knob.

Reference to Table 3 indicates that four of these controls were judged to be relatively realistic in the modified 1-CA-1. The Cyclic, Pedals, and Collective—controls which play an important role in aircraft control—were judged to be relatively unrealistic in either direction of movement or effect upon displays. The consensus of the pilots who made the realism ratings was that the Cyclic and the Pedals required unrealistic directions of movement (in order to obtain a given effect), and the Collective had an unrealistic effect upon the appropriate displays when comparison was made with typical Army helicopters. Thus, it must be concluded that dissimilarity exists between responses required to operate the three most important controls used in the training and in the criterion situations.

The TCA indicated an important omission from the list of common controls: the Throttle. Since adjustment of the Throttle is required in the TH-13T whenever a change is made from one steady state condition to another, the lack of a Throttle in the modified 1-CA-1 constitutes an important dissimilarity in response capability between the training and the criterion situation.

Two facts significantly limit the potential of the device from the standpoint of transfer of training: (a) training involving power adjustment through the Throttle in response to information displayed on the Engine Tachometer cannot be provided in the

¹⁴ Smode, A.F., *et al.*, *op. cit.*

¹⁵ An instrument labeled Engine Tachometer is present in the 1-CA-1. It does not function, however. For purposes of this research, instruments and controls in the 1-CA-1 which do not function are considered to be missing.

1-CA-1, and (b) Throttle (i.e., RPM) control is an important aspect of the aircraft control task in the TH-13T. Furthermore, the fact that the displays in the 1-CA-1 and the TH-13T are similar, but the responses required to operate the Cyclic, Pedals, and Collective are dissimilar, leads to a prediction of negative transfer of training from the 1-CA-1 to the TH-13T where aircraft control skills are concerned. Only in the relatively insignificant cases of training pilots to adjust the altimeter, set the clock, adjust radio volume, and speak through the microphone, are the stimuli and responses involved appropriate to a prediction of positive transfer of training from the training device to the criterion equipment.

Communication

Under instrument conditions, communication takes place between the pilot and the copilot, and between the pilot or copilot and certain ground stations. Communication stimuli are received through earphones¹⁶ in both the TH-13T and the 1-CA-1. Simulation of the copilot and of ground communication stations can be provided in the 1-CA-1 by the device operator. The stimuli presented to the pilot to simulate these two sources of communication were judged by the research staff to be realistic in the 1-CA-1 (except that the signal received by the pilot in the device typically is superior in quality to that received in the TH-13T).

From the response standpoint, the pilot of the 1-CA-1 has only two operable communications controls which have counterparts in the TH-13T, the Microphone Button and the Volume Control. It was the consensus of the TH-13T instructor pilots who evaluated the 1-CA-1 display and controls, as indicated in Tables 2 and 3, that these two controls were realistic when compared to the corresponding controls in typical Army helicopters. Thus, within the limitation imposed by the availability of only two communication controls, the stimuli and responses necessary to tactical instrument communication are similar in the 1-CA-1 and the TH-13T. Positive transfer can be predicted.

The communication function of tuning radios, as required in the TH-13T, is not possible in the 1-CA-1. It should be noted, however, that this function is performed by the copilot in the TH-13T, upon verbal instruction from the pilot. This situation may be simulated in the 1-CA-1 by instructing the device operator to perform the radio tuning function when requested to do so by the trainee.

ADDITIONAL TRAINING PROGRAM CONSIDERATIONS

The modified 1-CA-1 was investigated to determine whether it had any capabilities that might contribute positively to its training usefulness but that had not been noted in the systematic analyses described above. In addition, the O/WORWAC Tactical Instrument Training syllabus was reviewed to identify any areas of training that might be conducted, in part, in the modified 1-CA-1 but that had not otherwise been noted in the present study. Two such areas were noted for further investigation.

Environmental Simulation

The 1-CA-1 provides the capability of simulating three aspects of the environment in which the simulated aircraft operates: wind direction and intensity, turbulence, and electromagnetic signals. The similarity of the stimuli presented by this simulation to the

¹⁶ Earphones are not identified as common equipment in Table 1. Earphones are contained in the pilot's personal flight helmet which he uses in the TH-13T, rather than being an integral part of the aircraft. Headsets are integral to the training device.

pilot in the modified 1-CA-1 and the TH-13T was observed by the research staff, and, after consultation with the TH-13T instructor pilots, was judged to be realistic. The effect upon aircraft navigation of simulation of wind direction and intensity subjectively corresponds closely to the corresponding effect in the TH-13T. The simulation of turbulence in the device corresponds subjectively to that experienced in the TH-13T, except that the degree of turbulence in the device is not as great as that which may be experienced in the aircraft. Simulations in the device of all electronic signals which originate outside the aircraft (e.g., ground-based radio navigation stations) were judged to be realistic representations of the corresponding signals in the aircraft with one exception—aural station identifiers typically are missing. This defect in the simulation is considered of little consequence in the present instance, since the information the aural station identifiers provide is redundant.

Thus, the extra-aircraft environmental stimuli presented in the modified 1-CA-1 and the TH-13T are similar. The responses made to these stimuli all involve, to one degree or another, manipulation of the controls of the aircraft; therefore, the above comments dealing with aircraft control apply. It should be noted, however, that certain procedural aspects of the responses required to environmental effects are similar in the training and criterion situations in spite of the dissimilarity of aircraft control responses. For example, corrections for wind are similar, procedurally, in the two situations, although the specific psychomotor responses required of the pilot are dissimilar.

Training in the modified 1-CA-1 in the procedural aspects of responding to environmental stimuli may be predicted to result in positive transfer to the criterion situation, although certain aircraft control responses being practiced during such training will lead to negative transfer. The net result of such training is questionable, since most of the responses which must be made to environmental stimuli involve aircraft control to a greater degree than procedures.

Aircraft Malfunction

Too few of the displays and the controls in the modified 1-CA-1 are sufficiently similar to those of the TH-13T to justify consideration of using the training device to train pilots to cope with TH-13T systems (e.g., engine) malfunctions. Malfunctions of certain instruments, however, can be simulated in the device in order to teach the pilot to fly under "partial panel" conditions. In the case of attitude control, for example, the Attitude Indicator may be failed in the modified 1-CA-1 by turning the Artificial Horizon On-Off Selector to the Off position. The simulation of failure of other instruments may be accomplished simply by taping a mask over the instruments and requiring the pilot to fly by reference to the remaining unmasked instruments.

The simulation of instrument malfunctions in the modified 1-CA-1 is realistic when compared to the malfunction of corresponding instruments in typical Army helicopters in that such simulation requires the pilot in the device to resort to the remaining instruments for the appropriate stimuli for aircraft control. Although the stimuli are realistic, the responses required of the pilot are those of aircraft control, and the previous comments concerning transfer of aircraft control training apply. So far as training in the modified 1-CA-1 to cope with instrument malfunction in the TH-13T is concerned, negative transfer is predicted.

An important part of "partial panel" training is teaching the pilot to respond correctly to the standby compass. The standby compass, however, is not considered operable in the modified 1-CA-1. Therefore, those aspects of "partial panel" flight training which depend on this instrument (i.e., training for compass lead, lag, acceleration, and deceleration effects) cannot be provided in the device.

DEVELOPMENT OF A TRAINING PROGRAM

The analyses described also provide the basis for the development of a training program. In such activity, the two rules to be followed are: (a) maximize positive transfer of training, and (b) minimize negative transfer of training.

In the case of the specific training program which was the subject of analysis in this study, it is apparent that significant improvements in criterion performance will not result from a new program of instruction for the old device. It would appear that nothing can be done to avoid some amount of negative transfer of aircraft control training from the modified 1-CA-1 to the criterion situation because any use of the device likely to lead to positive transfer of other skills inevitably will require the trainee to practice inappropriate aircraft control responses.

As a consequence of this situation, the design of a new program of instruction, an original objective of the research program of which this report is a part, was determined to be of insufficient value to the Aviation School to warrant an extensive development program. Nevertheless, any degree of improvement in the O/WORWAC training program would be of some value. Therefore, changes in emphasis in the training being conducted in the modified 1-CA-1 devices would probably be of benefit by providing slight improvements in aviator proficiency in the aircraft. These changes in emphasis are indicated below:

(1) The best way to avoid negative transfer of skills is to eliminate the source of the negative transfer. This could be done in the O/WORWAC by teaching trainees attitude flying in the TH-13T before any training is given in the 1-CA-1. All aircraft control training could be provided in the aircraft. After the trainee has learned to control the aircraft, the incompatible responses he must make in the 1-CA-1 while learning procedures will be less likely to interfere with subsequent criterion performance.

(2) It is useless to require the trainee to develop high skill levels in the control of the 1-CA-1; being able to "fly" the 1-CA-1 to tight tolerances has no intrinsic value in terms of performance in an aircraft. Being able to control altitude to ± 100 feet in the 1-CA-1, for example, will not enable him to control altitude any better in the TH-13T. In fact, the reverse may be true.

(3) It would be desirable to minimize instruction in maneuvers in the 1-CA-1 which involve frequent throttle adjustment. The absence of a throttle and an engine tachometer in the 1-CA-1 is possibly a major source of negative transfer of training. Attempting to teach acceleration and deceleration, for example, can only make bad matters worse.

(4) It would appear that use of the 1-CA-1 in the tactical instrument training program can be justified only for procedures training. Therefore, instruction in which the device is used would most profitably concentrate on procedures. Emphasis on anything other than procedures should be avoided, even to the extent of allowing very "sloppy" flying.

CONCLUSION

The primary objective of the research described here, to develop systematic, analytic procedures that will enable training personnel to assess the utility of an existing device for a new training purpose, was met. These procedures permit the estimation of the transfer of training value of a device when employed in a new or a to-be-developed training program and provide substantive guidance to the training officer responsible for efficient use of the device.

The procedures were applied to an existing training system where the transfer of training value of a flight training device had been determined empirically during earlier research. A general lack of task commonality was found between the device and the operational aircraft, and predictions were made that the device would have little transfer of training value. These predictions were generally compatible with the findings during the earlier research that, overall, there were no consistent indications that the device-trained groups differed, in terms of performance in the aircraft, from groups without such training.

Applications of these analytic procedures are not limited to evaluations of existing devices in new training programs. Other applications include:

- (1) Comparison of several devices, either in the inventory or available commercially, to determine which one would be best suited for a known training device requirement. Situations where such an application would be appropriate include those in which a less-than-fully satisfactory device might provide an interim solution to a training problem while an appropriately designed device is being developed.

- (2) Investigation of a prototype device to verify the suitability of its design prior to awarding follow-on procurement contracts. Situations where such an application would be appropriate include those in which circumstances preclude immediate empirical validation of the prototype's design features.

- (3) Analysis of existing training programs in which training devices are employed to determine whether optimum use is being made of those devices.

The procedures described in this report are general in application. Throughout their development, it was intended that they apply to all military as well as nonmilitary situations in which training devices are employed in the development of operationally required skills.

The secondary objective of this research, to develop a training program which could make effective use of the Army's rotary wing modified 1-CA-1, was not met. The application of the analytic procedures to the training situation in which that device was employed led to the conclusion that significant improvements in criterion performance would not result from a new program of instruction for the old device due to negative transfer factors previously discussed.

APPENDICES

Appendix A

DISPLAYS AND CONTROLS FOUND IN THE TH-13T AIRCRAFT

I. Displays

A. Flight instruments

- (1) Airspeed Indicator
- (2) Standby Compass
- (3) Standby Compass Deviation Card
- (4) Attitude Indicator
- (5) Attitude Indicator Power Off Warning Flag
- (6) Altimeter
- (7) Vertical Velocity Indicator
- (8) Bearing Heading Indicator Heading Card
- (9) Bearing Heading Indicator Deviation Card
- (10) Turn and Slip Indicator

B. System Status Instruments

- (1) Chip Detector Light
- (2) Fuel Boost Fail Light
- (3) Heater Fail Light
- (4) Inverter Fail Light
- (5) Cylinder Head Temperature Indicator
- (6) Fuel Gage
- (7) Loadmeter
- (8) Engine Gage
 - (a) Engine Oil Temperature
 - (b) Transmission Oil Temperature
 - (c) Oil Pressure
 - (d) Fuel Pressure
- (9) Tachometer
 - (a) Rotor
 - (b) Engine
- (10) Manifold Pressure Gage
 - (a) Manifold Pressure
 - (b) Compressor Pressure
- (11) Carburetor Air Temperature Gage
 - (a) Carburetor Air Temperature
 - (b) Filter Air Temperature

C. Radio Navigation Instruments and Displays

- (1) Marker Beacon Light¹
- (2) Course (Omni) Indicator¹
 - (a) Course Pointer and Reciprocal Pointer¹
 - (b) Off Vertical Flag¹
 - (c) Off Horizontal Flag¹
 - (d) To-From Meter¹
 - (e) Vertical Pointer¹
 - (f) Horizontal Pointer¹

- (3) Bearing Heading Indicator
 - (a) ADF Pointer
 - (b) Omni Pointer¹
- D. Miscellaneous Instruments and Displays
 - (1) Elapsed Time Clock
 - (2) TH-13T Frequency Card
 - (3) Transmitter Selector Decal
 - (4) Radio Call Placard

II. Controls

- A. Flight Control Systems
 - (1) Cyclic
 - (2) Cyclic Friction Adjuster
 - (3) Collective Pitch
 - (4) Collective Pitch Friction Adjuster
 - (5) Tail Rotor Control Pedals
 - (6) Tail Rotor Pedal Adjustment Controls
 - (7) Altimeter Setting Control
 - (8) Attitude Indicator Adjustment Controls
 - (a) Pitch Adjustment Control
 - (b) Roll Adjustment Control
 - (9) Phase A Attitude Indicator Circuit Breaker
 - (10) Phase B Attitude Indicator Circuit Breaker
 - (11) Compass Slaving Switch
 - (12) Turn and Slip Indicator Circuit Breaker
 - (13) Instrument Circuit Breaker
 - (14) Vertical Velocity Indicator Adjustment Screw
- B. Aircraft System Control
 - (1) Throttle
 - (2) Throttle Friction Adjuster
 - (3) Fuel Pump Circuit Breaker
 - (4) Fuel Mixture Control
 - (5) Fuel Shut-Off Control Knob
 - (6) Engine Start Button
 - (7) Engine and Transmission Oil Temperature Selector Switch
 - (8) Manifold Purge Valve Button
 - (9) Carburetor Heat Control
 - (10) Hydraulic System On-Off Switch
 - (11) Hydraulic Circuit Breaker
 - (12) Ignition Switch
 - (13) Battery On-Off Switch
 - (14) Generator On-Off Switch
 - (15) Engine Starter Circuit Breaker
 - (16) Inverter Circuit Breaker
 - (17) Inverter Spare Switch
 - (18) Phase A Inverter Fail Relay Circuit Breaker
- C. Radio Navigation/Communication Controls
 - (1) UHF Command Radio Set Control Panel
 - (a) On-Off Switch
 - (b) Channel Selector
 - (c) Volume Control
 - (d) Tone Button
 - (e) Remote-Local Switch

- (2) UHF Circuit Breaker
- (3) Signal Distribution Panel
 - (a) Receiver Switches, 1, 2, 3, and 4
 - (b) Receiver Interphone Switch
 - (c) Receiver Navigation Switch
 - (d) Volume Control
 - (e) Transmit-Interphone Selector Switch
- (4) ICS Circuit Breaker
- (5) VOR-ILS Control Panel¹
 - (a) Volume-Off Switch¹
 - (b) Squelch Control¹
 - (c) Whole Megacycle Channel Selector Switch¹
 - (d) Fractional Megacycle Channel Selector Switch¹
- (6) VOR Circuit Breaker¹
- (7) Marker Beacon Volume-Off Control¹
- (8) Marker Beacon Sensing Switch¹
- (9) Omni Course Selector Knob¹
- (10) Marker Beacon/Glide Slope Circuit Breaker¹
- (11) ADF Receiver Control Panel
 - (a) MC Band Switch
 - (b) Volume Off Control
 - (c) Function Switch
 - (d) Loop Switch
 - (e) Tuning Control
 - (f) BFO Switch
- (12) ADF Circuit Breaker
- (13) Bearing Heading Indicator Controls
 - (a) Heading Synchronization Knob
 - (b) Set Heading Knob
 - (c) VOR-ADF Knob¹
- (14) DG-401 Compass Circuit Breaker
- (15) Phase A DG-401 Compass Circuit Breaker
- (16) Phase C DG-401 Compass Circuit Breaker
- (17) Radio Light Rheostat
- (18) Radio Microphone Switch
- (19) ICS Microphone Switch
- (20) ICS Foot Switch
- D. Auxiliary Equipment Controls
 - (1) Door-Mounted Cabin Ventilator
 - (2) Cabin Heater Controls
 - (a) Heater Start Switch
 - (b) Heater Control Switch
 - (c) Heater Power Switch
 - (d) Heater Blower Switch
 - (e) Cabin Heater Thermostat Control
 - (f) Fire Shut-Off Control
 - (3) Cockpit Light Rheostat
 - (4) Instrument Lights Rheostat
 - (5) Position Lights On-Off Switch
 - (6) Anti-Collision Lights On-Off Switch
 - (7) Landing Light On-Off Switch
 - (8) Cockpit Lights Circuit Breaker

- (9) Caution Lights Circuit Breaker
- (10) Landing Lights Circuit Breaker
- (11) Instrument Light Circuit Breaker
- (12) Bubble Defrost Knob
- (13) Elapsed Time Clock Set and Control Knob
- (14) Shoulder Harness Lock Knob
- (15) 26-Volt AC Transformer Circuit Breaker
- (16) Radio Lights Rheostat

¹ Indicates displays and controls associated with VOR-ILS systems. The VOR-ILS and associated displays and controls are not used in the Tactical Instrument training portion of the O/WORWAC. All other displays and controls in the TH-13T are used by the student pilot or the instructor pilot or are of potential use to them during the course.

Appendix B

DISPLAYS AND CONTROLS FOUND IN 1-CA-1 DEVICE MODIFIED AT USAAVNS TO A ROTARY WING CONFIGURATION

I. Displays

A. Attitude Instruments

- (1) Standby Compass^{1, 2}
- (2) Airspeed Indicator
- (3) Attitude Indicator
- (4) Altimeter
- (5) Turn and Slip Indicator
- (6) Radio Magnetic Indicator
- (7) Vertical Velocity Indicator

B. System Status Instruments

- (1) Engine Tachometer³
- (2) Manifold Pressure Gage
- (3) Vacuum Gage^{1, 4}
- (4) Fuel Quantity Gage^{1, 5, 6}
- (5) Fuel Pressure Gage^{1, 5}
- (6) Oil Temperature Gage^{1, 5}
- (7) Air Temperature Gage^{1, 5}
- (8) Carburetor Temperature Gage⁵
- (9) Oil Pressure Gage^{1, 5}

C. Radio Navigation Instruments and Displays

- (1) Radio Compass Indicator^{4, 5, 6}
- (2) Army Cross Pointer Center Line Deviation Indicator
- (3) Army Cross Pointer To-From Indicator
- (4) Radio Magnetic Indicator ADF Pointer
- (5) Radio Magnetic Indicator Omni Pointer
- (6) Course Selector Display
- (7) Marker Beacon Indicator Light

D. Miscellaneous Instruments and Displays

- (1) 8-Day Clock
- (2) Radio Call Label

II. Controls

A. Flight Control System

- (1) Cyclic
- (2) Pedals
- (3) Collective Pitch Stick
- (4) Attitude Indicator Horizontal Adjustment Control
- (5) Altimeter Adjustment Control
- (6) Radio Compass Indicator Magnetic Variation Adjustment^{1, 4}
- (7) Turn and Bank Gyro-Off Switch⁴

- B. Aircraft Systems Control
 - (1) Ignition Switch
 - (2) Fuel Tank Selector^{4, 5}
 - (3) Master Off-On Switch
 - (4) Carburetor Open-Close Cooling Shutter Lever^{4, 5}
 - (5) Oil Open-Close Cooling Shutters Lever^{4, 5}
 - (6) Cowl Open-Close Cooling Shutters Lever^{4, 5}
 - (7) Pitot Heater Off-On Switch⁴
- C. Radio Navigation/Communication Control
 - (1) Army Cross Pointer Center Line Deviation Indicator Adjustment Screw⁴
 - (2) Army Cross Pointer To-From Indicator Adjustment Screw⁴
 - (3) Course Selector Knob
 - (4) I.F.F. Control Switch^{4, 5}
 - (5) Antenna Selector Switch⁵
 - (6) Loop Drive Switch⁵
 - (7) Instrument Landing Switch⁵
 - (8) To-From Switch^{4, 5}
 - (9) Glide Path Control^{5, 7}
 - (10) Off-Flight-Land Switch^{5, 7}
 - (11) Inner-Outer-Range-Tower Selector Switch^{5, 7}
 - (12) Voice-Both-Range Switch^{5, 7}
 - (13) Volume Control
 - (14) Pilot's Tuning Control^{5, 7}
 - (15) Microphone Button
- D. Auxiliary Equipment Controls
 - (1) 8-Day Clock Set and Control Knob
 - (2) Trainer Lock-Release Lever⁴
 - (3) Instrument Lights Off-On Switch
 - (4) Cockpit Lights Rheostat
 - (5) Door Knob

¹ Indicator displays and controls found in fewer than 80% of the rotary wing modified 1-CA-1s.

² The Standby Compass is functional but incorporates error typically as high as 60° and is not used.

³ The Engine Tachometer registers 0 RPM when the Master Switch is off and a fixed operational value when the Master Switch is on. Its function is related to no other controls or displays.

⁴ Indicates displays and controls which are present in the rotary wing modified 1-CA-1 and perform functions for which there are no counterparts in the TH-13T.

⁵ Indicates displays and controls which are inoperative or nonfunctioning.

⁶ Approximately 25% of the rotary wing modified 1-CA-1s have a Fuel Quantity Gage; the remaining 75% have a Radio Compass Indicator in its place.

⁷ Indicates controls which are present in the rotary wing modified 1-CA-1 but for which there are no counterparts in the TH-13T; the function performed by these controls, however, can be performed by other means in the TH-13T.

Appendix C

MODIFIED 1-CA-1 DISPLAYS AND CONTROLS WHICH ARE OPERATIONAL IN A MAJORITY OF THE AVAILABLE DEVICES

- I. Displays
 - A. Attitude Instruments
 - (1) Airspeed Indicator
 - (2) Attitude Indicator
 - (3) Altimeter
 - (4) Turn and Slip Indicator
 - (5) Radio Magnetic Indicator Heading Card
 - (6) Vertical Velocity Indicator
 - B. System Status Instruments
 - (1) Manifold Pressure Gage
 - C. Radio Navigation Instruments and Displays
 - (1) Army Cross Pointer Center Line Deviation Indicator
 - (2) Army Cross Pointer To-From Indicator
 - (3) Radio Magnetic Indicator ADF Pointer
 - (4) Radio Magnetic Indicator Omni Pointer
 - (5) Course Selector Display
 - (6) Marker Beacon Indicator Light
 - D. Miscellaneous Instruments and Displays
 - (1) 8-Day Clock
 - (2) Radio Call Label
- II. Controls
 - A. Flight Control System
 - (1) Cyclic
 - (2) Pedals
 - (3) Collective Pitch Stick
 - (4) Attitude Indicator Horizontal Adjustment Control
 - (5) Altimeter Adjustment Control
 - (6) Turn and Bank Gyro-Off Switch¹
 - B. Aircraft Systems Control
 - (1) Ignition Switch
 - (2) Master Off-On Switch
 - (3) Pitot Heater Off-On Switch¹
 - C. Radio Navigation/Communication Control
 - (1) Army Cross Pointer Center Line Deviation Indicator Adjustment Screw¹
 - (2) Army Cross Pointer To-From Indicator Adjustment Screw¹
 - (3) Course Selector Knob
 - (4) Volume Control
 - (5) Microphone Button

D. Auxiliary Equipment Controls

- (1) 8-Day Clock Set and Control Knob
- (2) Trainer Lock-Release Lever¹
- (3) Instrument Lights Off-On Switch
- (4) Cockpit Lights Rheostat
- (5) Door Knob¹

¹Indicates displays and controls which are present in the rotary wing modified 1-CA-1 and perform functions for which there are no counterparts in the TH-13T.

Appendix D

ANALYSIS OF A REPRESENTATIVE FLIGHT MANEUVER PERFORMED DURING A TACTICAL INSTRUMENT MISSION IN THE TH-13T AIRCRAFT

MANEUVER: INSTRUMENT TAKE-OFF (ITO) AND CLIMB TO A SPECIFIED ALTITUDE
(Maneuver begins with the aircraft in position for ITO and all engine gages in the green)

Task ¹	Display	Stimulus	Information	Responses
Communications:	Radio	1. Clearance from base airfield to destination	1a. Aircraft (A/C) identification	1a. Copy clearance (adjust audio volume if required)
			1b. Clearance limit	1b. Transmit repeat of clearance (push-to-talk switch)
			1c. Route of flight	
			1d. Altitude data	
			1e. Departure procedure	
			1f. Holding instructions	
			1g. Any special information	
		2. Take-off clearance	2a. Direction of take-off	2a. Set heading on Bearing Heading Indicator (BHI) using magnetic compass
			2b. Sequence of take-off	2b. Set barometric pressure on altimeter
			2c. Altimeter setting	2c. Set time on clock
Take Off:	Verify Heading		2d. Time	2d. Transmit acknowledgment
	Bearing Heading Indicator (BHI)	1. Heading card reading	2e. Wing direction and velocity	
		1. Twist throttle counter-clockwise (CCW)		
		1a. Stop throttle when needle reaches 3200 RPM		
		1b. Raise collective pitch lever		
Control Rotor and Engine RPM	Tachometer	1. Needles moving clockwise (CW) to 3200 (engine) RPM		

(Continued)

<u>Task¹</u>	<u>Display</u>	<u>Stimulus</u>	<u>Information</u>	<u>Responses</u>
Control Power	Manifold Pressure (MP) Indicator	1. Needle moving CW	1. Take-off power being applied	1. Stop collective pitch at take-off power 33" MP. Maintain 33" MP
Control Trim	Turn & Slip Indicator	1. Ball out to the left of center	1. Yaw to the right	1. Push on left pedal
Control Pitch	Attitude Indicator (primary for ITO)	1. Minature A/C nose on horizon bar	1. A/C in level attitude	1. Push cyclic forward to acceleration attitude 2 bar widths below horizon
	Airspeed Indicator (secondary for ITO)	1. Pointer moving CW to 50 knots (K) 2. Pointer moving CCW from 50K 3. Pointer moving CW from 50K	1. Airspeed climbing 2. A/C climbing too rapidly 3. A/C climbing too slowly	1. Pull cyclic back upper reaching 50K 2. Push cyclic forward to maintain 50K 3. Pull cyclic back to maintain 50K
	Vertical Speed Indicator (VSI) (secondary for ITO, primary for climb)	1. Pointer moving CW to 500 feet per minute (fpm) 2. Pointer not moving CW to 500 fpm position 3. Pointer moving CW from 500 fpm position	1. Climb approaching standard rate 2. A/C climbing too slowly 3. A/C climbing too fast	1. When 500 fpm reached, reduce power to climb setting 27" MP by lowering collective 2. Pull cyclic back 3. Push cyclic forward
Climb: Adjust Power	Manifold Pressure	1. Needle moving CCW	1. Approaching climb MP setting	1a. Adjust throttle to maintain 3200 RPM 1b. Ease off left torque pedal
	Tachometer	1. Needle moving CW from 3200 RPM 2. Needle moving CCW from 3200 RPM	1. RPM high 2. RPM too low	1. Twist throttle CW 2. Twist throttle CCW

— (Continued) —

<u>Task¹</u>	<u>Display</u>	<u>Stimulus</u>	<u>Information</u>	<u>Responses</u>
Control Bank	Attitude Horizon (secondary for climb)	1. Miniature A/C nose ½ bar width above horizon bar	1. 50K climbing attitude	1. Maintain with cyclic
		1. Needle moving CW	1. Aircraft climbing	1. Cross check VSI for 500 fpm climb. Maintain with cyclic.
	Altimeter (secondary for ITO)	1. Miniature A/C wings parallel to horizon bar	1. Straight climb attitude	1. Maintain cyclic in center position laterally
		2. Miniature A/C wings slanted down to right	2. A/C in right bank	2. Move cyclic to the left
	Attitude Indicator (primary for ITO, secondary for climb)	3. Miniature A/C wings slanted down to left	3. A/C in left bank	3. Move cyclic to the right
		1. Needle vertical	1. A/C in straight flight	1. Maintain cyclic in center laterally
	Turn Needle (secondary for ITO and climb)	2. Needle moving CW from vertical	2. A/C in turn to right	2. Move cyclic to the left
		3. Needle moving CCW from vertical	3. A/C in turn to left	3. Move cyclic to the right
	BHI (secondary for ITO, primary for climb)	1. Heading card rotating CCW	1. A/C in turn to right	1. Move cyclic to the left
		2. Heading card rotating CW	2. A/C in turn to left	2. Move cyclic to the right
Control Trim	Turn & Slip Indicator	1. Ball to right of center when turn needle is indicating no turn	1. A/C is in left yaw	1. Push right pedal
		2. Ball to left of center when turn needle is indicating no turn	2. A/C is in right yaw	2. Push left pedal
Control Power	Airspeed Indicator	1. Needle moving CW from 50K	1. A/C climbing with power	1. Lower collective to main- tain 50K
		2. Needle moving CCW from 50K	2. A/C climbing without enough power	2. Raise collective to main- tain 50K

— (Continued) —

<u>Task,¹</u>	<u>Display</u>	<u>Stimulus</u>	<u>Information</u>	<u>Responses</u>
Level Off:				
Control Pitch	Altimeter (primary for pitch)	1. Needle moving CW	1. Reaching desired altitude	1. Push forward on cyclic 30 to 40 ft. before reaching desired altitude
	Altitude Indicator (secondary for pitch)	1. Minature A/C nose on horizon bar	1. Cruise altitude	1. Maintain with cyclic
	VSI (secondary for pitch)	1. Needle in horizontal position	1. A/C in level flight	1. Maintain with cyclic
Control Power	Airspeed Indicator	1. Needle moving CW to 60K	1. A/C approaching cruise speed	1. Reduce power with collective to maintain 60K airspeed
	Tachometer	1. Needle not indicating 3200 RPM	1. Throttle needs adjustment	1. Adjust throttle to maintain 3200 RPM
	Turn & Slip Indicator	1. Turn needle vertical but ball off center	1. Trim needs adjustment	1. Control yaw with torque pedal
Control Heading	BHI	1. Heading card turning	1. Heading not steady	1. Control heading with cyclic

¹Many of the tasks indicated in this maneuver occur concurrently rather than sequentially as suggested by the format employed. In like manner, the sequence employed in viewing the listed displays to obtain information, the sequence of response made, etc., are not necessarily restricted to the sequence indicated here.

Unclassified

Security Classification

DOCUMENT CONTROL DATA - R & D		
(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)		
1. ORIGINATING ACTIVITY (Corporate author) Human Resources Research Organization (HumRRO) 300 North Washington Street Alexandria, Virginia 22314		2a. REPORT SECURITY CLASSIFICATION
		2b. GROUP
3. REPORT TITLE EQUIPMENT-DEVICE TASK COMMONALITY ANALYSIS AND TRANSFER OF TRAINING		
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Technical Report		
5. AUTHOR(S) (First name, middle initial, last name) Paul W. Caro		
6. REPORT DATE June 1970	7a. TOTAL NO. OF PAGES 34	7b. NO. OF REFS 4
8a. CONTRACT OR GRANT NO. DAHC-19-70-0012		9a. ORIGINATOR'S REPORT NUMBER(S) Technical Report 70-7
b. PROJECT NO. 2Q062107A712		9b. OTHER REPORT NO.(S) (Any other numbers that may be assigned this report)
c. d.		
10. DISTRIBUTION STATEMENT This document has been approved for public release and sale; its distribution is unlimited.		
11. SUPPLEMENTARY NOTES Work Unit ECHO, Synthetic Flight Training Programs and Devices		12. SPONSORING MILITARY ACTIVITY Office, Chief of Research and Development Department of the Army Washington, D.C. 20310
13. ABSTRACT Procedures were developed to enable training personnel systematically and objectively to determine the potential utility of training devices for teaching how to perform missions in operational equipment. The procedures allow comparison of operational task stimulus and response elements with corresponding elements in synthetic training equipment. On the basis of such information, training programs consistent with the psychological principles underlying transfer of training may be developed. The procedures may be applied to the potential use of training equipment in a training situation other than that for which it was designed, or in determining the applicability of "off-the-shelf" training devices to specific training requirements. The procedures, termed Task Commonality Analysis, were developed in connection with an Army rotary wing instrument flight training program. In an application of the procedures in that program, transfer of training predictions were generally consistent with empirical evidence collected earlier.		

DD FORM 1473
1 NOV 65

Unclassified

Security Classification

Unclassified

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Flight Training						
Helicopter Training						
Job Description						
Performance Prediction						
Rotary Wing Training						
Simulation						
Synthetic Training						
Task Analysis						
Task Commonality Analysis						
Training						
Training Devices						
Transfer of Training						

Unclassified

Security Classification

DISTRIBUTION LIST

2 DIR DASH MANPOWER (PPEGR)
1 CHF DASH ATTN DDC LIB BR
1 DIR WSEF WASH., D.C. 20305
1 DIR DASH MANPOWER & RESERVE AFFAIRS
1 OFC OF THE ASST SEC OF DEF (MGR) ATTN SPEC ASST POLICY STUDIES
2 COMDR FLD COMD DEF ATOMIC SPT AGY SANDIA BASE ATTN FCTG7
2 NASA SCI & TECH INFO FACILITY COLLEGE PARK MD
1 CINC US EUROPEAN COMD ATTN SUPPORT PLANS BR J3
1 CINC USA PACIFIC ATTN G3 CDC APO SAN FRAN 96610
2 CG SOUTHERN EUROPEAN TASK FORCE APO 9616R NY
1 CG US ARMY JAPAN APO 96343 SAN FRAN ATTN G3
10 CG USA FORCES SOUTHERN COMD ATTN SCARCO FT AMADOR C2
1 CG US ARMY ALASKA ATTN ARACD APO 98749 NY
2 CG US ARMY EUROPE APO 09403 NY ATTN OPNS DIV
1 CG ARMY TRANS RES COMD FT EUSTIS ATTN TECH LTR
1 CG US ARMY AD COMD ENT AFB ATTN ADGCR
6 CG 1ST ARMY ATTN DCSOT FT MEADE MD
1 CG 3RD ARMY ATTN DCSOT FT MCPHERSON
2 CG 4TH ARMY ATTN ANACD-RUFT FT SAM HOUSTON
2 CG FOURTH ARMY FT SAM HOUSTON ATTN G3
7 CG FIFTH ARMY FT SHERIDAN ATTN ALGCG TNG
1 CG SIXTH ARMY PRES OF SAN FRAN ATTN AMAAV
1 CG EUSA ATTN AG-AC APO 96301 SAN FRAN
1 CLIN PSYCHOL SERV DEPT OF NEUROPSYCHIAT WALTER REED GEN HOSP
1 DIR HEL APG MD
1 CG USA CDC EXPERIMENTATION COMD FT ORD
2 ENGNR PSYCHOL LAB PIONEERING RES DIV ARMY NATICK LABS NATICK MASS
1 TECH LTR ARMY NATICK LABS NATICK MASS
2 INST OF LAND CBT ATTN TECH LTR FT BELVOIR VA
1 REDSTONE SCIENTIFIC INFO CTR US ARMY MSL COMD ATTN CHF DDC SEC ALA
1 CG USADA HOLTV DET TDDHANNA ARMY DEPOT
1 CG FT HUACHUCA SPT COMD USA ATTN TECH REF LIB
1 CG 1ST AIR DEF GUIDED MSL BRGD TNG FT BLISS
12 CG US ARMY CDC EXPERIMENTATION COMD FT ORD
1 SIXTH USA LTR DEPOT BLDG W 13 14 PRES OF SAN FRAN
1 PLANS OFFICER PSYCH MODRES USACDCFC FORT ORD
5 CG FT ORD ATTN G3 TNG DIV
1 DIR WALTER REED ARMY INST OF RES WALTER REED ARMY MED CTR
2 DIR WRAP WALTER REED ARMY MED CTR ATTN NEUROPSYCHIAT DIV
1 CG HQ ARMY ENLISTED EVAL CTR FT BENJ HARRISON
1 TECH LTR ARMY 22 USACDC EXPERIMENTATION COMD FT ORD
1 HUMAN FACTORS TEST DIV (ADH2) USAF HOSP EGLIN AFB
1 CG FRANKFORD ARSNL ATTN SMUFA-N6400/202-4
1 6TH RGN USARAFCON FT BAKER
1 4TH ARMY MSL COMD AIR TRANSPORTABLE SAN FRAN
1 PERS SURSYS DIV CREW SURSYS DRCT AFRO SYS DIV WRIGHT-PAT.
1 DIR ARMY RD FOR AVN ACCIDENT RES FT RUCKER
2 CG PICATINNY ARSNL DOWER N J ATTN SUMP VCI
1 DEF SUPPLY AGY CAMERON STATION ATTN LIB
2 CG USA CDC AG AGCY FT BENJ HARRISON IND
1 REF M MS TS NASA ALA
1 CRT OPNS RES GP USACDC SP OPNS ANALYST HUMAN FACTORS ALEX VA
1 CG ARMY CDC INF AGY FT BENNING
1 CG ARMY CDC ARMOR AGY FT KNOX
8 ARMY CDC SPEC WARFARE AGY FT BRAGG
1 EVAL DIV DAD ARMY SIG CTR & SCH FT MONMOUTH
1 CG US ARMY CDC AVN AGCY FT RUCKER
3 CG ARMY CRT DEVEL COMD CRT SUPPORT GP
15 CG USA TNG CTR AD ATTN ACOFS G3 FT BLISS
1 CG USA TNG CTR ARMOR ATTN ACOFS G3 FT KNOX
12 CG USA TNG CTR (FA) ATTN ACOFS G3 FT SILL
1 CG USA TNG CTR 6 FT LEONARD WOOD ATTN ACOFS G3
1 CG USA TNG CTR INF ATTN ACOFS G3 FT BENNING
1 CG USA TNG CTR INF ATTN ACOFS G3 FT DIX
1 CG USA TNG CTR INF ATTN ACOFS G3 FT JACKSON
1 CG USA TNG CTR INF ATTN ACOFS G3 FT LEWIS
1 CG USA TNG CTR INF & FT ORD ATTN ACOFS G3
30 CG USA TNG CTR INF ATTN ACOFS G3 FT POLK
5 CG USA MED TNG CTR ATTN DIR OF TNG FT SAM HOUSTON
1 CG USA TNG CTR INF ATTN ACOFS G3 FT BRAGG
1 CG USA TNG CTR INF ATTN ACOFS G3 FT CAMPRELL
2 CIVLN PERS OFCR US ARMY SPT CTR ST LOUIS ATTN EMPLOYEE DEVEL OFCR
3 LTR ARMY WAR COLL CARLISLE ARS
1 COMDT COMD & GEN STAFF CO FT LEAVENWORTH ATTN ARCHIVES
1 DIR OF MILIT PSYCHOL & LDRSHIP US MILIT ACAD WEST POINT
1 US MILIT ACAD WEST POINT ATTN LTR
1 COMDT ARMY AVN SCH ATTN DIR OF INSTR FT RUCKER
2 COMDT ARMY SECUR AGY TNG CTR & SCH FT DEVENS ATTN LTR
1 COMDT INSTR COLL OF THE ARMED FORCES FT MCNAIR
2 COMDT NATL WAR COLL FT LESLEY J MCNAIR ATTN CLASS RECORDS BR LTR
1 MED FLD SERV SCH BROOKE ARMY MED CTR FT SAM HOUSTON ATTN STIMSON LTR
3 DIR OF INSTR ARMOR SCH FT KNOX
1 COMDT ARMY ARMOR SCH FT KNOX ATTN WEAPONS DEPT
1 COMDT USA CHAPLAIN SCH ATTN DDI FT HAMILTON
1 COMDT ARMY CHFM CORPS SCH FT MCCLELLAN ATTN EDUC ADV
1 COMDT USA FIN SCH ATTN CHF DDC DEV LIT PLN DIV IND
1 USA FINANCE SCH FT BENJ HARRISON ATTN EDUC ADV
6 COMDT ARMY ADJ GEN SCH FT BENJ HARRISON ATTN EDUC ARN
1 EDUC ADV USAIS ATTN AJIIS-H FT BENNING
1 DIR OF INSTR USAIS ATTN AJIIS-D-EPRO FT BENNING
1 HQ US ARMY ADJ GEN SCH FT BENJ HARRISON ATTN COMDT
1 LTR ARMY QM SCH FT LEE
1 COMDT ARMY QM SCH FT LEE ATTN EDUC ADV
1 COMDT ARMY TRANS SCH FT EUSTIS ATTN EDUC ADV
1 CG USA SEC AGY TNG CTR & SCH ATTN IATEV RSCH ADV FT DEVENS
1 COMDT ARMY MILIT POLICE SCH FT GORDON ATTN DIR OF INSTR
2 COMDT US ARMY SOUTHEASTERN SIG SCH ATTN: EDUC ADVISOR FT GORDON
1 COMDT USA AD SCH FT BLISS
1 CG USA ORD CTR & SCH OFC OF OPS ATTN AMAN-D APO MD
5 ASST COMDT ARMY AIR DEF SCH FT BLISS ATTN CLASSF TECH LTR
10 CG USA FLD ARTY CTR ATTN AVN OFCR FT SILL
1 COMDT ARMY DEPT INTEL SCH ATTN STIAS DEPT
1 COMDT ARMED FORCES STAFF COLL NORFOLK
1 COMDT USA SIG CTR & SCH ATTN DDI FT MONMOUTH
1 COMDT JUDGE ADVOCATE GENERALS SCH U OF VA
1 DPT COMDT USA AVN SCH ELEMENT GA
1 DPT ASST COMDT USA AVN SCH ELEMENT GA
1 USA AVN SCH ELEMENT OFC OF DIR OF INSTR ATTN EDUC ADV GA
1 EDUC CONSLT ARMY MILIT POLICE SCH FT GORDON
6 COMDT USA ENGR SCH ATTN EDUC ADV FT BELVOIR
2 COMDT US ARMY SCH EUROPE ATTN REF LIB APO 09172 NY
1 CHF POLICY & TNG LIT DIV ARMY ARMOR SCH FT KNOX
1 COMDT ARMY AVN SCH FT RUCKER ATTN EDUC ADV
1 COMDT ARMY PRINW SCH FT WOLTERS
1 DIR OF INSTR US MIL ACAD WEST POINT NY
1 DIR OF MILIT INSTR US MILIT ACAD WEST POINT
1 USA INST FOR MIL ASSIST ATTN LTR FT BRAGG
4 USA INST FOR MIL ASSIST ATTN COUNTERINSURGENCY DEPT FT BRAGG
1 ARMY SIG CTR & SCH FT MONMOUTH ATTN TNG LIT DIV DAD
2 COMDT USA MSL & MUN CTR & SCH ATTN CHF OFC OF OPS REDSTONE ARSNL
2 COMDT US WAC SCH US WAC CTR ATTN AJMCT FT MCCLELLAN
2 HQ ABERDEEN PG ATTN TECH LTR
1 COMDT USA INTELL SCH ATTN DIR OF ACADEMIC OPS FT HOLABIRD
1 COMDT USA INTELL SCH ATTN DIR OF DDC & LIT FT HOLABIRD
1 COMDT USA CDDC OFC OF CHF OF RESIDENT INSTR FT LEAVENWORTH
1 COMDT USA CA SCH ATTN DEPT OF RSCH ANALYSIS & DDC FT GORDON
1 COMDT USA CA SCH ATTN DDI FT GORDON
1 COMDT USA CA SCH ATTN EDUC ADV FT GORDON
1 COMDT USA CA SCH ATTN LTR FT GORDON
1 COMDT USA SCH & TNG CTR ATTN ACOFS G3 TNG DIV FT MCCLELLAN
1 COMDT USA SCH & TNG CTR ATTN ACOFS G3 PLNS & OPS DIV FT MCCLELLAN
1 COMDT USA INST FOR MIL ASSIST ATTN DDI FT BRAGG
10 COMDT USA CBR WPNS ORIENTATION COURSE ATTN DDI DUGWAY UTAH
1 COMDT USA FLD ARTY SCH ATTN DDI FT SILL
1 COMDT USA ARTY & MSL SCH ATTN EDUC SERVICES DIV FT SILL
1 COMDT USA ARTY & MSL SCH ATTN EDUC ADV FT SILL
1 COMDT USA TRANS SCH ATTN DIR OF DDC & LIT FT EUSTIS
1 COMDT USA TRANS SCH ATTN LTR FT EUSTIS
1 USA INST FOR MIL ASST ATTN EDUC ADV FT BRAGG
1 COMDT ARMY QM SCH OFC DIR OF NONRES ACTVY ATTN TNG MEDIA DIV VA
1 CG USA ARTY & MSL SCH ATTN LTR FT SILL
1 CG USA SCH & TNG CTR ATTN ACOFS G3 FT GORDON
1 COMDT USA AD SCH ATTN AKRAAS-DL-FA FT BLISS
2 DIR BRGD & BN OPNS DEPT USAIS FT BENNING
1 DIR COMM ELFC USAIS FT BENNING
1 DIR ABN-AIR MOBILITY DEPT USAIS FT BENNING
2 DIR COMPANY TACTICS DEPT USAIS FT BENNING
1 CG US ARMY SIGNAL CTR SCH ATTN SIGDOL-3 (COMET III)
1 SECY OF ARMY, PENTAGON
1 DCS-PERS DA ATTN CHF C+S DIV
1 DIR OF PERS STUDIES & RSCH DDCSPER DA WASH DC
1 CG FOREIGN SCI & TECH CTR MUN PLNG
2 ACSFOR DA ATTN CHF TNG DIV WASH DC
1 CG USA MAT COMD ATTN AMCRD-TE
1 CHF OF ENGRNS DA ATTN ENGTG-T
1 HQ ARMY MAT COMD R&D DRCTE ATTN AMCRD-RC
2 CG ARMY MED R&D COMD ATTN REHAB SCI RES BR
1 US ARMY BEHAVIORAL SCI RES LAB WASH., D.C. ATTN: CRD-AR
1 OPD PERS MGT DEV OFC ATTN MOS SEC (NEW EQUIP) OPDMD
1 ARMY PROVOST MARSHAL GEN
1 DIR CIVIL AFFAIRS DRCTE DDCSPDS
1 OFC RESERVE COMMON DA
2 CG USA SEC AGCY ARL HALL STA ATTN AC OF S GI VA
50 ADMIN DDC ATTN: TCA (HEALY) CAMERON STA ALEX., VA. 22314
1 CG US ARMY MED RES LAB FT KNOX
1 CG ARMY FLECT COMD FT MONMOUTH ATTN AMSEL CR
1 CHF OF R&D DA ATTN CHF TECH & INSTR LIAISON OFC
2 CG ARMY MED R&D COMD ATTN MEDH-SR
1 U S ARMY BEHAVIORAL SCI RES LAB WASH., D.C. ATTN-CRIC
1 COMDT USA CRT SURVEIL SCH & TNG CTR ATT ED ADV FT HUACHUCA
1 COMDT USA CRT SURVEIL SCH & TNG CTR ATTN ORG DDC & NEW EQUIP ART7
2 TNG & DEVEL DIV DDCS-PERS
1 COMDT USA CRT SURVEIL SCH & TNG CTR ATTN CRT TNG BDE ART7
1 CAREER MGT BR ATTN R DETIENNE CAMERON STA ALEX VA
1 PRES ARMY ARMOR RD FT KNOX
1 PRES ARMY MAINT BD FT KNOX
2 PRES ARMY AVN TEST BD FT RUCKER
2 PRES ARMY ARTY BD FT SILL
1 DPT PRES ARMY MAT COMD RD ABERDEEN PG
15 CG USCONARC ATTN ATIT-RD-RE FT MONROE
2 CG USCONARC ATTN LTR FT MONROE
1 CG ARMY CBT DEVEL COMD MILIT POLICE AGY FT GORDON
1 US ARMY ARCTIC TEST CTR R & D OFFICE SEATTLE
1 CHF USA AD HRU FT BLISS
1 CHF USA ARMOR HRU FT KNOX
1 CHF USA AVN HRU FT RUCKER
1 CHF USA INF HRU FT BENNING
1 CHF USA TNG CTR HRU PRES OF MONTEREY
1 CG 2D ARMORED DIV FT HODD ATTN DIV AVN OFCR
6 CG 4TH ARMORED DIV ATTN DCSOT APO NY 09326

4 CO 2D ARMORED CAV REGT APO 09034 NY
 1 CO 3D ARMORED CAV REGT APO 09034 NY
 1 CO 14TH ARMORED CAV REGT APO 09026 NY
 2 CG ARMY ARMOR & ARTY FIRING CTR FT STEWART ATTN AC OF S TNG OFCR
 1 1ST ARMORED DIV HQ & HQ CO FT HOOD ATTN AC OF S G2
 10 CO 1ST BN 63RD ARMOR 1ST INF DIV ATTN S3 FT RILEY
 4 CO 1ST BN 64TH ARMOR 3RD INF DIV ATTN S3 APO NY 09031
 2 CO 1ST BN 73RD ARMOR 7TH INF DIV ATTN S3 APO SAN FRAN 96207
 8 CO 2ND BN 68TH ARMOR 8TH INF DIV ATTN S3 APO NY 09034
 1 CO COMPANY A 3D BN 32D ARMOR 3D ARMORED DIV APO NY
 1 CO 5TH BN 33D ARMOR ATTN S3 FT KNOX
 1 CO 3RD BN 37TH ARMOR 4TH ARMORED DIV ATTN S3 APO NY 09066
 2 CO 2ND BN 34TH ARMOR 25TH INF DIV ATTN S3 APO SAN FRAN 96266
 2 CALIF NG 40TH ARMORED DIV LOS ANGELES ATTN AC OF S G3
 1 95TH COMD HQ DIV ARMY NG JACKSONVILLE FLA
 4 CO 150TH AVN BN NJ AIR NG ELIZABETH
 1 CG HQ 27TH ARMORED DIV NY AIR NG SYRACUSE
 1 TEXAS NG 49TH ARMORED DIV DALLAS
 1 CG ARMY ARMOR CTR FT KNOX ATTN G3 AIRCFT
 2 CG 1ST INF DIV ATTN ACOPS G3 APO SAN FRAN 96145
 1 CG 3RD INF DIV ATTN ACOPS G3 APO NY 09036
 1 CG 4TH INF DIV ATTN ACOPS G3 APO SAN FRAN 96262
 1 CG 7TH INF DIV ATTN ACOPS G2 APO SAN FRAN 96207
 1 CG 8TH INF DIV ATTN ACOPS G2 APO NY 09111
 1 CG 5TH INF DIV (MECH) & FT CARSON ATTN ACOPS G2 COLD
 3 CG 82ND ABN INF DIV ATTN ACOPS G3 FT BRAGG
 1 CO 197TH INF BRD FT BENNING ATTN S3
 1 CO 1ST BN (REINF) ATTN S3 FT MYER
 1 CO HQTRS 2ND BN 6TH US INF REGT ATTN S3 APO NY 09742
 7 CO 3RD BN 6TH INF REGT ATTN S3 APO NY 09742
 1 CO 171ST INF BDE ATTN S3 APO SEATTLE 98731
 3 CG 25TH INF DIV APO 96225 SAN FRAN
 1 CO 1ST BN 39TH INF 8TH INF DIV ATTN S3 APO NY 09034
 1 CO 2ND BN 15TH INF 3RD INF DIV ATTN S3 APO NY 09026
 5 CG 24TH INF DIV ATTN ACOPS G3 FT RILEY
 4 CO 1ST BN (MECH) 52ND INF 198TH INF BDE ATTN S3 APO SAN FRAN 96219
 4 CO 4TH BN (MECH) 54TH INF ATTN S3 FT KNOX
 1 CO USA PARTIC GP USN TNG DEVICE CTR FLA
 2 CONSOL RES GP 7TH PSYOP GP APO 96248 SAN FRAN
 2 DA OFC OF ASST CH OF STAFF FOR COM-ELCT ATTN CETS-A WASH
 1 CHM MED RES PROJ ARMY HOSP US MILIT ACAD WEST POINT
 1 DIR ARMY LTR PENTAGON
 1 STRATEGIC PLANNING GP CORPS OF ENGR ARMY MAP SERV
 1 CHM OF MILIT HIST DA ATTN GFM REF BR
 1 CO USA 10TH SPEC FORCES GP FT DEVENS
 1 CO 24TH ARTY GP (AD) ATTN S3 RI
 1 CG 31ST ARTY BDE AD ATTN S3 PA
 1 CO 49TH ARTY GP AD ATTN S3 FT LAWTON
 2 HQS 4TH BN 59TH ARTY REGT ATTN S3 NORFOLK
 1 CO 28TH ARTY GP AD ATTN S3 SELFPRIDGE AFB
 1 CO 52ND ARTY BDE AD ATTN S3 FT HANCOCK
 1 HQS 45TH ARTY BDE AD ATTN S3 ARL HTS ILL
 1 CO 35TH ARTY BDE AD ATTN S3 FT MEADE MD
 1 CG 101ST ABN DIV (AIRBORNE) ATTN ACOPS G3 APO SAN FRAN 96383
 1 CG 1ST CAV (AIRBORNE) ATTN ACOPS G3 APO SAN FRAN 96383
 1 US ARMY GEN EQUIP ATTN TECH LTR FT LEE
 1 US ARMY TROPIC TEST CTR PO DAMER 942 ATTN BEHAV SCIEN CZ
 8 CG III CORPS & FT HOOD ATTN G3 SEC FT HOOD
 30 CO 1ST ARMORED DIV ATTN G3 SEC FT HOOD
 10 CO 2D ARMORED DIV ATTN G3 SEC FT HOOD
 29 CO 13TH SUPT AGDE ATTN S3 SEC FT HOOD
 10 CG USAFAC ATTN G3 SEC FT SILL
 20 CO III CORPS ATTN G3 SEC FT SILL
 20 CG USA AD CTR ATTN G3 SEC FT BLISS
 20 CG ATTN G3 SEC FT POLK LA
 1 RESD AOD OFC CHM OF RES WASH DC
 1 CHM OF RES DA ATTN SCI INFO BR RSCH SPT DIV WASH DC
 2 CINC US PACIFIC FLY FPO 96614 SAN FRAN
 1 CINC US ATLANTIC FLY CODE 312A USN RASE NORFOLK
 1 CINC PACIFIC OPNS ANLS SECT FPO 96610 SAN FRAN
 1 CDR TNG COMMAND US PACIFIC FLY SAN DIEGO
 1 CHM BUR OF MED + SURG ON ATTN CODE 913
 1 HEAD CLIN PSYCHOL SECT PROFESNL DIV BUR OF MED + SURG ON
 5 TECH LTR PERS LTR BUR OF NAV PERS ARL ANNER
 3 DIR PERS RES DIV BUR OF NAV PERS
 1 TECH LTR BUR OF SHIPS CODE 210R NAVY DEPT
 1 HUMAN FACTORS BR PSYCHOL RES DIV ONR
 1 ENGRN PSYCHOL BR ONR CODE 458 ATTN ASST HEAD WASH DC
 3 CO + DIR NAV TNG DEVICE CTR ORLANDO ATTN TECH LTR
 1 CO FLT ANTI-AIR WARFARE TNG SAN DIEGO
 1 CO NUCLEAR WEAPONS TNG CTR PACIFIC U S NAV AIR STA SAN DIEGO
 1 CO NAV AIR DEVEL CTR JOHNSVILLE PENNA ATTN NADC LIR
 2 FLT ANTI-AIR WARFARE TNG CTR DAN NECK VA BEACH
 2 CO FLT TNG CTR NAV BASE NEWPORT
 2 CO FLT TNG CTR NORFOLK
 3 CO FLEET TNG CTR U S NAV STA SAN DIEGO
 1 CLIN PSYCHOL MENTAL HYGIENE UNIT US NAV ACAD ANNAPOLIS
 1 PRES NAV WAR COLL NEWPORT ATTN MAHAN LIR
 2 CO + DIR ATLANTIC FLT ANTI-SUB WARFARE TACTICAL SCH NORFOLK
 1 CO NUCLEAR WEAPONS TNG CTR ATLANTIC NAV AIR STA NORFOLK
 2 CO FLT SONAR SCH KEY WEST
 1 CO FLT ANTI-SUB WARFARE SCH SAN DIEGO
 1 CHM OF NAV RES ATTN SPEC ASST FOR R & D
 1 CHM OF NAV RES ATTN HEAD PERS + TNG BR CODE 458
 1 CHM OF NAV RES ATTN HEAD GP PSYCHOL BR CODE 452
 1 DIR US NAV RES LAB ATTN CODE 9120
 1 DIR NAVAL RSCH ATTN LIR CODE 2029 (ONRL) WASH DC
 1 CHM OF NAV AIR TNG TNG RES DEPT NAV AIR STA PENSACOLA
 1 CO NAV SCH OF AVN MED NAV AVN MED CTR PENSACOLA
 1 CO MED FLD RES LAB CAMP LEJEUNE
 1 CDR NAV MSL CTR POINT MUGU CALIF ATTN TECH LTR CODE 3022
 1 DIR AEROSPACE CREW EQUIP LAB NAV AIR ENGRN CTR PA
 2 OIC NAV PERS RES ACTVY SAN DIEGO
 1 NAV NEUROPSYCHIAT RES UNIT SAN DIEGO
 2 NAVAL MSL CTR (CODE 9342) FT MUGU CALIF
 1 DIR PERS RES LAB NAV PERS PROGRAM SUPPORT ACTIVITY WASH NAV VO
 1 NAV TNG PERS CTR NAV STA NAV VO ANNER CODE R3 ATTN LTR WASH
 1 COMDT MARINE CORPS HQ MARINE CORPS ATTN CODE AD-1B
 1 HQ MARINE CORPS ATTN AR
 1 DIR MARINE CORPS EDUC CTR MARINE CORPS SCH QUANTICO
 1 DIR MARINE CORPS INST ATTN EVAL UNIT
 1 CHM OF NAV OPNS OP-01P1
 1 CHM OF NAVL OPS OP-037 WASH DC
 1 CHM OF NAV OPNS OP-0772
 2 COMDT HQS 8TH NAV DIST ATTN EDUC ADV NEW ORLEANS
 1 CHM OF NAV AIR TECH TNG NAV AIR STA MEMPHIS
 1 DIR OPS EVAL GRP OFC OF CHM OF NAV OPS OP03EG
 2 COMDT RYP COAST GUARD HQ
 1 CHM OFCR PERS RES + REVIEW BR COAST GUARD HQ
 1 CO US COAST GUARD TNG CTR GOVERNORS ISLAND NY
 1 CO US COAST GUARD TNG CTR CAPE MAY NJ
 1 CO US COAST GUARD TNG CTR E SUP CTR ALAMEDA CALIF
 1 CO US COAST GUARD INST OKLA CITY OKLA
 1 CO US COAST GUARD RES TNG CTR YORKTOWN VA
 1 SURT US COAST GUARD ACAD NEW LONDON CTNN
 1 OPNS ANLS OFC HQ STRATEGIC AID COMD OFFUTT AFB
 1 AIR TNG COMD RANDOLPH AFB ATTN ATTNM
 1 TECH DIR TECH TNG DIV (HND) AFHRL LOWRY AFB COLJ
 1 CHM SCI DIV DRYCE SCI + TECH DCS R4D HQ AIR FORCE AFSTA
 1 FAA DRYCE OF PLNS & OPS HQ USAF WASH DC
 1 CHM OF PERS RES BR DRYCE OF CIVILIAN PERS DCS-PERS HQ AIR FORCE
 1 CHM ANAL DIV (AFPOPL IRI) DIR OF PERSONNEL PLANNING HQS USAF
 1 AFSC-STLO (RTSAMI) CO DEPT OF THE NAVY
 1 HQ AFSC SCAB ANDREWS AFB
 2 CDR ELEC SYS DIV L G HANSCOM FLD ATTN ESRHA BEDFORD MASS
 1 HQ SAMS (SMSIR) AF UNIT POST OFC LA AFS CALIF
 1 MILIT TNG CTR OFC LACKLAND AFB
 2 AFHRL (HRT) WRIGHT-PATTERSON AFB
 1 AMO AMRH BROOK AFB TEXAS
 1 HQS ATC DCS/TECH TNG (ATTMS) RANDOLPH AFB
 4 HQS ATC (ATCTD-M) RANDOLPH AFB TEXAS
 1 CDR ELEC SYS DIV LG HANSCOM FLD ATTN ESTE
 1 DIR AIR U LTR MAXWELL AFB ATTN AIL37-63-253
 1 AIR FORCE SCH OF AEROSPACE MED BROOKS AFB ATTN AEROMED LIR
 1 DIR OF LTR US AIR FORCE ACAD
 1 COMDT REF WPNS SYS MGT CTR AF INST OF TECH WRIGHT-PATTERSON AFB
 1 COMDT ATTN LTR DEF WPNS SYS MGT CTR AF INST OF TECH WRIGHT-PAT.
 1 ASTOTH PERS BR PERS AF INST OF TECH WRIGHT-PATTERSON AFB
 1 TECH TNG CTR (LWTC/OP-11) LOWRY AFB
 2 AF HUMAN RESOURCES LAB WRIGHT-PATTERSON AFB
 2 CO HUMAN RESOURCES LAB BROOKS AFB
 1 PSYCHOBIOLOGY PROG NATL SCI FOUND
 1 DIR NATL SECUR AGY FT GEO G MEADE ATTN TOL
 1 DIR NATL SECUR AGY FT GEO G MEADE ATTN DIR OF TNG
 5 CIA ATTN OCA/ADD STANDARD DIST
 1 SYS EVAL DIV RES DIRECTORATE DOD-DCO PENTAGON
 1 DEPT OF STATE BUR OF INTEL + RES EXTERNAL RES STAFF
 1 SCI INFO EXCH WASHINGTON
 2 CHM MCT & GEN TNG DIV FR 200 FAA WASH DC
 1 BUR OF RES & ENGR US POST OFC DEPT ATTN CHM HUMAN FACTORS BR
 1 EDUC MEDIA BR DEPT OF HEW ATTN T D CLEMENS
 1 OFC OF INTERNATL TNG PLANNING & EVAL BR AID WASH DC
 1 FAA MED LTR HQ 640 WASH DC
 1 DEPT OF TRANS FAA ACQ SFC HQ 610A WASH DC
 1 SYS DEVEL CORP SANTA MONICA ATTN LIR
 2 DUNLAP + ASSOC INC DARIEN ATTN LIR
 2 RAC ATTN LIR MCLEAN VA
 1 RAND CORP WASHINGTON ATTN LIR
 1 DIR RAND CORP SANTA MONICA ATTN LIR
 1 GRP EFFECTIVENESS RSCH LAB U OF ILL DEPT OF PSYCHOL
 1 U OF SO CALIF ELEC PERS RES GP
 1 COLUMBIA U ELEC RES LABS ATTN TECH EDITOR
 1 METRE CORP BEDFORD MASS ATTN LIR
 2 SIMULATION ENGR CORP ATTN DIR OF ENGR FAIRFAX VA
 2 U OF PM LEARNING R4D CTR ATTN DIR
 1 WESTERN ELECTRIC CO INC NY
 1 HUMAN SCI RES INC MCLEAN VA
 2 TECH INFO CTR ENGRN DATA SERV 4 AMER AVN INC COLUMBUS O
 1 CHRYSLER CORP MSL DIV DETROIT ATTN TECH INFO CTR
 1 RAYTHEON SERV CO ATTN LIR BURLINGTON MASS
 2 EDUC & TNG CONSULTANTS ATTN L SILVERN LA
 1 GEN DYNAMICS POMONA DIV ATTN LIR DIV CALIF
 2 MARQUARDT INDSTR PROD CO CUCAMONGA CALIF
 1 OTIS ELEVATOR CO DIV ATTN LIR STAMFORD CONN
 1 MGR BIOTECHNOLOGY AEROSPACE SYS DIV MS BN-25 BOEING CO SEATTLE
 2 CTR FOR RES IN SOCIAL SYS FLD OFC FT BRAGG
 1 IDA RSCH & PNG SUPT DIV ARL VA
 1 HUGHES AIRCRAFT COMPANY CULVER CITY CALIF
 1 DIR CTR FOR RES ON LEARNING + TEACHING U OF MICH
 1 R + STODGILL THIRD STATE UNIV
 1 EDITOR TNG RES ARSTR AMER SOC OF TNG DIRS U OF TENN
 1 U OF CHICAGO DEPT OF SOC
 1 HUMAN FACTORS SECT R4D GEN DYNAMICS ELECTRIC BOAT GROTON
 1 CTR FOR RES IN SOCIAL SYS AMER U
 6 BRITISH EMBRY BRITISH DEF RES STAFF WASHINGTON
 3 CANADIAN JOINT STAFF OFC OF DEF RES MEMBER WASHINGTON
 3 CANADIAN ARMY STAFF WASHINGTON ATTN GS02 TNG
 2 CANADIAN LIAISON OFCR ARMY ARMOR 80 FT KNOX
 1 GERMAN LIAISON OFCR ARMY AVN TEST 80 FT RUCKER
 3 ACS FOR INTEL FOREIGN LIAISON OFCR TO NORWEG MILIT ATTACHE
 1 BRITISH EMBRY ARSTR AMER SOC OF TNG DIRS U OF TENN
 1 DEF RES MED LAB ONTARIO
 3 AUSTRALIAN NAV ATTACHE EMBRY OF AUSTRALIA WASH DC
 2 FRENCH LIAISON OFCR ARMY AVN TEST 80 FT RUCKER
 1 BRITISH LIAISON OFCR ARMY AVN TEST 80 FT RUCKER
 1 OFC OF AIR ATTACHE AUSTRALIAN EMBRY ATTN: T.A. NAVSN WASH; D.C.
 2 AUSTRALIAN EMBRY OFC OF MILIT ATTACHE WASHINGTON
 2 U OF SHEFFIELD DEPT OF PSYCHOL
 1 MENNINGER FOUNDATION TOPEKA

2 AMER INST FOR RES SILVER SPRING
 1 AMER INST FOR RES PGM ATTN LIRN
 1 DIR PRIMATE LAB UNIV OF WIS MADISON
 1 COLUMBIA U SCH OF BUS
 1 MATRIX CORP ALEXANDRIA ATTN TECH LIRN
 1 AMER TEL&TEL CO NY
 1 U OF GEORGIA DEPT OF PSYCHOL
 1 DR GEORGE T HAUTY CHMN DEPT OF PSYCHOL U OF DEL
 1 GEN ELECTRIC CO SANTA BARBARA ATTN LIR
 1 VITRO LABS SILVER SPRING MD ATTN LIRN
 1 HEAD DEPT OF PSYCHOL UNIV OF SC COLUMBIA
 1 TVA ATTN CHM LABOR RELATIONS BR DIV OF PERS KNOXVILLE
 1 U OF GEORGIA DEPT OF PSYCHOL
 1 U OF UTAH DEPT OF PSYCHOL
 1 GE CO WASH D C
 1 AMER INST FOR RES PALO ALTO CALIF
 1 MICH STATE U COLL OF SOC SCI
 1 N MEX STATE U ATTN PROF OF PSYCHOL
 1 ROWLAND & CO HADDONFIELD NJ ATTN PRES
 1 NORTONICS DIV OF NORTHROP CORP ANAHEIM CALIF
 1 OHIO STATE U SCH OF AVN
 1 SCI RSCH ASSOC INC DIR OF EVAL CHICAGO ILL
 1 AIRCRAFT ARMAMENTS INC COCKEYSVILLE MD
 2 OREGON STATE U DEPT OF MILIT SCI ATTN ADJ
 1 TUFTS U HUMAN ENGRN INFC & ANLS PROJ
 1 AMER PSYCHOL ASSOC WASHINGTON ATTN PSYCHOL ABSTR
 1 NO ILL U HEAD DEPT OF PSYCHOL
 1 ENGRN LIR FAIRCHILD HILLER REPUBLIC AVN DIV FARMINGDALE N Y
 1 WASHINGTON ENGRN SERV CO INC KENSINGTON MD
 1 LIFE SCI INC FT WORTH ATTN PRES
 1 AMER BEHAV SCI CALIF
 2 DIR INSTR RESOURCES STATE COLL ST CLOUD MINN
 1 COLL OF WM & MARY SCH OF EDUC
 1 SO ILLINOIS U DEPT OF PSYCHOL
 2 COMMUNICABLE DISEASE CTR DEVEL & CONSULTATION SERV SECT ATLANTA
 2 WASH MILITARY SYS DIV BETHESDA MD
 1 NORTHWESTERN U DEPT OF INDIR ENGRN
 1 HONEYWELL ORD STA MAIL STA 806 MINN
 1 NY STATE EDUC DEPT ABSTRACT EDITOR AVCR
 1 AEROSPACE SAFETY DIV U OF SOUTHERN CALIF LA
 1 MR BRANDON R SMITH RES ASS - U OF MINN
 1 CTR FOR THE ADVANCED STUDY OF EDUC ADMIN U OF OREG
 1 DR V ZACHERT RT 2 NORMAN PARK GA
 1 J P LYDON DIR JR ROYC SAN ANTONIO TEXAS
 1 DR E FOULKE DEPT OF PSYCH UNIV OF LOUISVILLE
 1 DR E PERKINS PROF OF PSYCH ST CLOUD STATE COLL MINN
 1 MR S ATLES STPTOE C JOHNSON WASH DC
 1 DR W BEVAN VP & PROVOST THE JOHNS HOPKINS UNIV MD
 1 DR W C RTEL U OF SOUTHERN CALIF LA
 1 DR C W BRAY BOX 424 QUOGUE LI NY
 1 MR J M CHRISTIE PRES RIGGS NATL BANK WASH DC
 1 DR C W CLARK VP FOR RSCH RSCH TRIANGLE INST NC
 1 GEN H P HARRIS IUSA RETIPRES THE CITADEL SC
 1 DR L T RADER CHMN DEPT OF ELEC ENGRN U OF VA
 1 CHM PROCESSING DIV DUKE U LIR
 1 U OF CALIF GEN LIR OCCU DEPT
 2 FLORIDA STATE U LIB GIFTS & EXCH

1 PSYCHOL LIR HARVARD UNIV CAMBRIDGE
 1 U OF ILL LIR SER DEPT
 2 U OF KANSAS LIR PERIODICAL DEPT
 1 U OF NEBRASKA LIRS ACQ DEPT
 1 OHIO STATE U LIRS DEPT & EXCH DIV
 1 PENNA STATE U PATRFE LIB OCCU DEPT
 1 PURDUE U LIRS PERIODICALS CHECKING FILES
 1 STANFORD U LIRS OCCU LIR
 1 LIRN U OF TEXAS
 1 SYRACUSE U LIR SER DIV
 1 SERIALS REC UNIV OF MINN MINNEAPOLIS
 1 STATE U OF IOWA LIRS SER ACQ
 1 NC CAROLINA STATE COLL DM HILL LIR
 2 BOSTON U LIRS ACQ DIV
 1 U OF MICH LIRS SER DIV
 1 BROWN U LIR
 2 COLUMBIA U LIRS OCCU ACQ
 1 DIR JOINT U LIRS NASHVILLE
 2 LIR GEO WASH UNIV ATTN SPEC COLL DEPT WASH DC
 2 LIR OF CONGRESS CHM OF EXCH & GIFT DIV
 1 U OF RGH OCCU LIRN
 1 CATHOLIC U LIR EDUC & PSYCHOL LIR WASH DC
 1 U OF KY MARGARET I KING LIR
 1 SO ILL U ATTN LIRN SER DEPT
 1 KANSAS STATE U FARRELL LIR
 1 BRIGHAM YOUNG U LIR SER SECT
 1 U OF LOUISVILLE LIR BELKNAP CAMPUS
 1 G E RYAN JAYCOPTERS LTD NY NY
 1 SYSTEMS ENGR GR RSCH & TECH DIV AFSC WRIGHT-PATTERSON AFB
 1 S GRAYE TNG COORDINATOR HONEYWELL CALIF
 1 M E EASTER SCH OF AVN OHIO STATE UNIV COLUMBUS
 1 R E FLEKMAN DIR OF AVN INST UNIV OF ILL URBANA
 1 G C CONKLIN LINK GP GENRL PRECISION INC SILVER SPRING MD
 1 D E MEYER AFHRL BROOKS AFB TEXAS
 1 DR A F SMODE DUNLAP & ASSOC DARTEN CONN
 1 W B RONEY DNR NTDC FLA
 1 DR W T RICHARDSON NORTHROP CORP CALIF
 1 DR H KERRER LIFE SCI RSCH DEPT 459 GOODYEAR AEROSPACE CO OHIO
 1 G LUDWIG HELPAR INC FALLS CHURCH VA
 1 CHM DR TNG RR TNG RSCH DIV BEHAV SCI LAB OHIO
 1 CO NTDC ATTN CODE 55 ORLANDO FLA
 1 J CURTIN HUMAN FACTORS DEPT MCCONNELL-DOUGLAS CORP MO
 1 DR C R KELLEY DUNLAP & ASSOC SANTA MONICA CALIF
 1 S H COTTON JR SIMULATION ENGR CORP FAIRFAX VA
 1 R T CHESLOW LOGISTICS MGT INST WASH D C
 1 DR T H GRAY HONEYWELL CALIF
 1 DR J H GROSSLIGHT AD DEPT OF PSYCH FLA STATE UNIV
 1 DISPLAY SYS DEPT HUGHES AIRCRAFT CALIF
 1 G REID SPRING HUMAN FACTORS MP-537 MARTIN FLA
 1 G R POTTER DIR AVN SAFETY DIV UNIV OF SOUTHERN CALIF LA
 1 OFC OF SURGEON GENL ATTN AVN SEC DA
 1 USA TRANSPORTATION COMD ATTN F MCCOURT FT EUSTIS VA
 1 R A MONTY CORNELL AERONAUTICAL LAB NY
 1 DR K B DEGREENE UNIV OF SOUTHERN CALIF LA
 1 LRNG RESOURCES CTR UNIV OF TENN KNOXVILLE
 1 DR L W CURETON SCH OF EDUC UNIV OF TENN
 1 LIR EMBRY-RIDDLE AERONAUTICAL INST DAYTONA BEACH FLA

HUMAN RESOURCES RESEARCH ORGANIZATION

300 North Washington Street • Alexandria, Virginia 22314

President

Executive Vice President

Director for Business Affairs and Treasurer

Director for Operations

Director for Program Development

Director for Research Design and Reporting

Dr. Meredith P. Crawford

Dr. William A. McClelland

Mr. Charles W. Smith

Mr. Arnold A. Heyl

Dr. Robert G. Smith, Jr.

Dr. Eugene A. Coogan

RESEARCH DIVISIONS

HumRRO Division No. 1 (System Operations)

300 North Washington Street

Alexandria, Virginia 22314

Dr. J. Daniel Lyons

Director

HumRRO Division No. 2

Fort Knox, Kentucky 40121

Dr. Donald F. Haggard

Director

HumRRO Division No. 3

Post Office Box 5787

Presidio of Monterey, California 93940

Dr. Howard H. McFann

Director

HumRRO Division No. 4

Post Office Box 2086

Fort Benning, Georgia 31905

Dr. T.O. Jacobs

Director

HumRRO Division No. 5

Post Office Box 6057

Fort Bliss, Texas 79916

Dr. Robert D. Baldwin

Director

HumRRO Division No. 6 (Aviation)

Post Office Box 428

Fort Rucker, Alabama 36360

Dr. Wallace W. Prophet

Director

HumRRO Division No. 7 (Social Science)

300 North Washington Street

Alexandria, Virginia 22314

Dr. Arthur J. Hoehn

Director

END
DEPT. OF HEALTH
EDUCATION AND
WELFARE
U.S. OFFICE OF
EDUCATION
ERIC
DATE FILMED

10 24 73